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MAINTENANCE ENGINEERING

IN PLANTS, MILLS, AND FACTORIES

FORMERLY 'INDUSTRIAL ENGINEERING'

Looking at Tomorrow

IN THESE times it is heartening to be shown through establishments that are finding it difficult to keep up with orders. There are such plants. One plant visited recently is working 16 hours a day; another 24; a third is employing more men and working at a higher rate of production than ever before.

Are these plants especially favored in any way? No. All are units in highly competitive industries. The products are, respectively, radio receiving sets, flat and V-type belts, an automobile of medium price.

What magic formula has been invoked? Merely this: Manufacture of a superior product at a low unit cost.

In each case the designing engineers developed a product so inherently good that buyers find it difficult to say "No" to the salesmen. The production departments simplified and speeded up manufacturing operations by the use of the most modern equipment. The maintenance engineers provided adequate materials-handling equipment, good lighting and good working conditions for the employees, proper motors and controls for the machines, and the many necessary auxiliary services. Then they put into effect an inspection and maintenance routine that cuts repair costs, breakdowns, and production delays to the vanishing point.

We cannot escape the conclusion that these plants are blazing the trail which all manufacturers who expect to stay in business must follow for a long time to come.

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NOVEMBER
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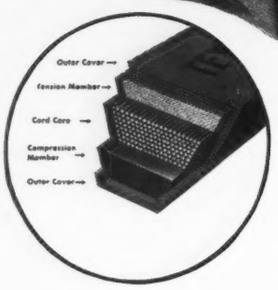
EXPERIENCE

. . . Is essential in solving your transmission problems



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Texrope Belts are made by B. F. Goodrich for Allis-Chalmers. How well these belts succeed in giving long service under constant flexing is indicated by four years continuous service on twisting frames, without replacement, in a textile mill. This is equivalent to 12 years average service at 8 hrs. per day.

THE Texrope Drive is the simplest form of transmission. Its correct *application* is an engineering problem . . . and experience in varied applications determines the success of the installation.

That is why Allis-Chalmers assumes absolute responsibility for the *complete drive*. That is why more than 125,000 Texrope Drives are in satisfactory service today. That is why some 25,000 users consistently praise this Allis-Chalmers product.

That is why Allis-Chalmers has established definite standards for belt sections and sheave diameters (both pressed steel and cast iron).

Experience *unequalled* is the most important part of the service offered by Texrope Drives . . . the experience of trained engineers . . . over 125,000 applications . . . covering a period of nearly seven years.

Lower prices are no substitute for experience . . . yet the prices of Texrope Drives are as low as they can be for the quality of materials, workmanship and *engineering service*.

A Texrope engineer is at your service. He can help cut your transmission costs and possibly eliminate trouble. Try him . . . on a drive that has been misbehaving.

ALLIS-CHALMERS MANUFACTURING COMPANY (*Texrope Division*)
MILWAUKEE *Specialists in Power Machinery Since 1846* WISCONSIN

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TEXROPE DRIVES

THE DRIVES THAT REVOLUTIONIZED TRANSMISSION PRACTICE . . .

MAINTENANCE ENGINEERING

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NOVEMBER, 1931

This New Plant Provides Easy Building Maintenance

C. G. BRADFIELD

Field Engineer
Point Breeze Works
Western Electric Company
Baltimore, Md.

"HOW SHALL WE insure low maintenance costs, adequate safety provisions, and good working conditions?" asked the Western Electric engineers of themselves in advance of building the Point Breeze plant. In this article field engineer Bradfield gives their answers.

LOW MAINTENANCE costs, safety, and good working conditions were important features sought in the design of the buildings in the Point Breeze Works of the Western Electric Company. The buildings thus far erected include the cable plant, insulated-wire building, boiler and turbine house, reel-repair shop, scale house, well house, well and oil house, and restaurant.

To obtain water cool enough for our purposes it was necessary to drill artesian wells at two locations in the yard, approximately 1,200 ft. apart. These wells are housed in small, attractive structures mentioned above, whose architectural treatment is the same as for the larger buildings.

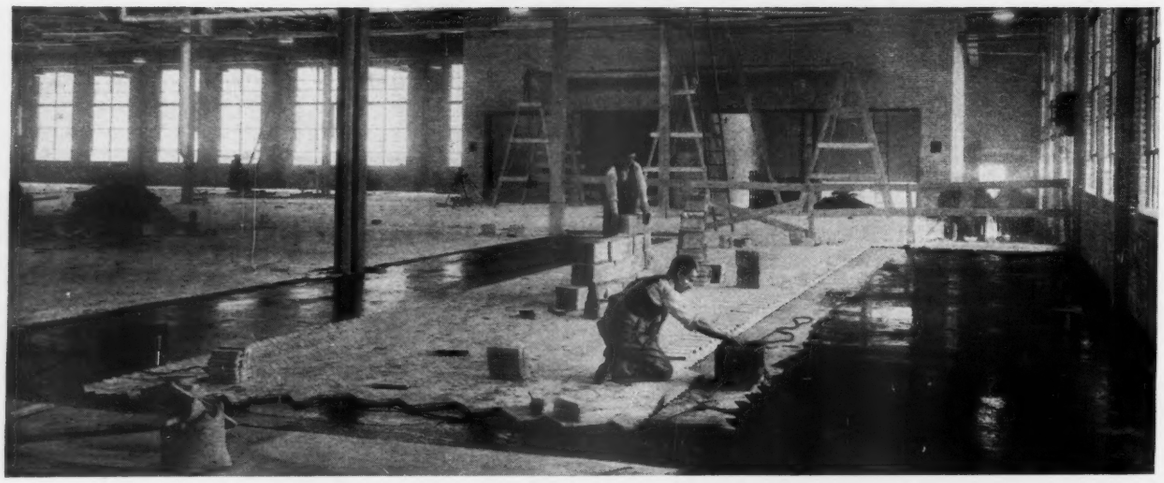
All buildings, with the exception of a three-story office section in the cable plant and the boiler and turbine house are conventional one-story structures with concrete foundation supporting a structural-steel framework inclosed by brick walls. Their roof decks are all of structural gypsum waterproofed with standard felt, asphalt, and slag coverings.

The floor of the insulated-wire building consists of hard maple blocks $10 \times 2\frac{1}{2} \times 1\frac{1}{16}$ in., with the edges cut so as to interlock when laid on the flat side with the grain of the wood parallel to the concrete, oil-treated base. Unlike some other wood blocks in common use, this type is not completely immersed in a bituminous compound before being laid in place; consequently, the natural color of the wood is preserved. The entire floor was laid in a herringbone pattern, and when new resembled a ballroom floor, rather than the floor of an industrial building. The advantages expected of this type of floor over other types are low maintenance, increased durability, a large silence factor, better appearance, and better working surface.

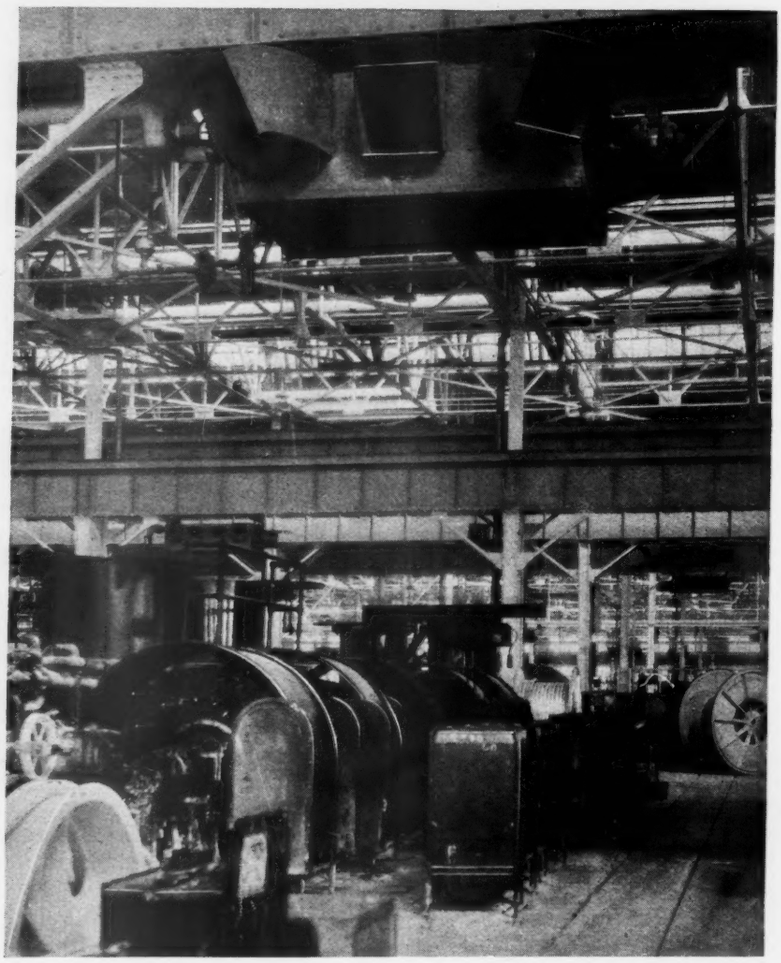
The floor in the cable plant is a treated-pine block floor laid in a bituminous compound. This type was chosen because of the heavy trucking and general hard usage to which the floor is subjected.

Floors in all of the other buildings are concrete; there was no reason to use wood blocks.

A large portion of the floor area is underlaid with a duct system to provide for power leads. This method of duct installation is an economical means of providing for a flexible power layout. In a plant where individual power units are the unexcepted rule it is an investment that will undoubtedly pay for itself, as a new machine installation will involve



Laying the wood-block floor in the insulated-wire building. The blocks are hard maple and are laid on a concrete base, oil-treated.



One of the 71 suspended-type unit heaters in the cable plant. These heaters are rated 414,000 B.t.u. per hour each, receive steam at 2-lb. pressure, and deliver about 5,560 cu.ft. of air per minute.

merely punching a hole in the floor at the duct line, which never is more than 10 ft. away. For the roof deck of the cable plant it was decided to use a precast gypsum block, 24x30x3 in. with cast-in reinforcing material consisting of three evenly spaced $\frac{3}{16}$-in. rods, laid on T-rails. This block will support a minimum live and dead load of 30 lb. per sq.ft. This type of roof deck was chosen for its fireproof qualities, sound-deadening effect, high heat insulation, low maintenance cost, and high lighting characteristic. Due to its lightness and ease of handling, it is possible to lay it very rapidly. A felt, tar, and slag waterproofing was applied over this deck.

Roof construction of the cable plant and the insulated wire building is radically different from the conventional design, The combination of V-type monitors and A-frames was designed to give better lighting than is obtained with the usual designs and it has been found to be eminently satisfactory. In the cable plant the intensity of daylight illumination (under a cloudless sky and with clean glass) has a minimum value of 16.5 foot-candles, and in the insulated-wire building a minimum of 14 foot-candles. The uniformity of light distribution is highly satisfactory, as tests have shown that the ratio of divergence in illumination in the cable plant is 3.7 to 1, whereas in the insulated wire building it is but 2.3 to 1. The intensity of the light under the V-monitors may be attributed to the reflecting value of the sloping roof deck.

The sidewall and monitor sash subjected to the direct rays of the sun were glazed with so-called actinic glass to reduce the objectionable glare. Although this resulted in a lowering of the illumination intensity within the building, it was found that the properties of the glass support the scientific theory that it does not reduce the speed or accuracy of vision.

Actinic glass is a special, amber-tinted glass designed to reduce the glare of the sunlight and to absorb

some of the heat rays. The theory is that the human eye focuses more readily that portion of the sun's light represented by the yellow or amber section of the spectrum. The light rays screened out by this glare-reducing glass lie principally in the blue end of the spectrum.

Continuous, top-hung, motor-operated sash was used in all roof monitors and A-frames. Standard pivoted, ventilator, motor-operated sash was used in all sidewalls. Double-hung, hand-operated, office-window-type sash is used in offices, scale house, well houses, and in portions of the restaurant building. It is felt that this installation represents the ultimate in providing good light and good ventilation for the workers. All lights in the insulated-wire building are mounted 16-ft. high in stationary fixtures. In the cable building, which is much higher, all areas not served by overhead traveling cranes are illuminated by lights, 388 in number, suspended from automatic hangers that permit the fixtures to be lowered. It is expected that the increased cost of these hangers will be absorbed quickly by the economies resulting from the ease and rapidity with which they can be lowered in order to clean or replace the bulbs or reflectors. Their use also eliminates the hazard that exists when ladders are used for cleaning or replacement of units.

These automatic hangers have also been installed in several areas in the power house.

All of the buildings at Point Breeze are well lighted to eliminate the accident hazards that lurk in dark places.

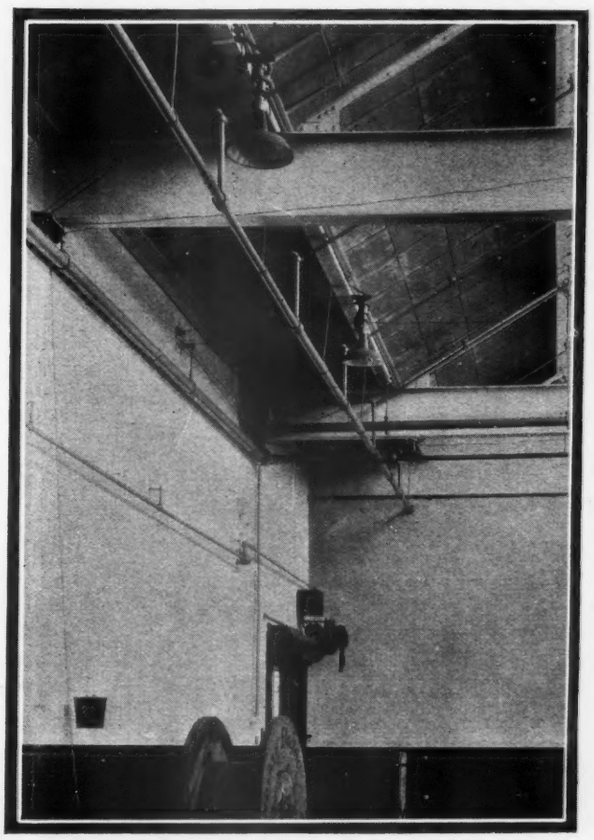
Interior walls are painted dado green to a height of 5 ft. 6 in. above the floor, and then mill white to the roof deck. The exposed structural steelwork in all buildings is also painted white. Salt-glazed brick was used in the interior walls of the power house. Therefore they do not need painting.

All of the buildings are heated by steam generated in the centrally located power house and transmitted to the various buildings through pipes running in underground tunnels. The steam is fed into suspended unit heaters, each of which is controlled by a separate thermostat. Thus regulated temperature is insured.

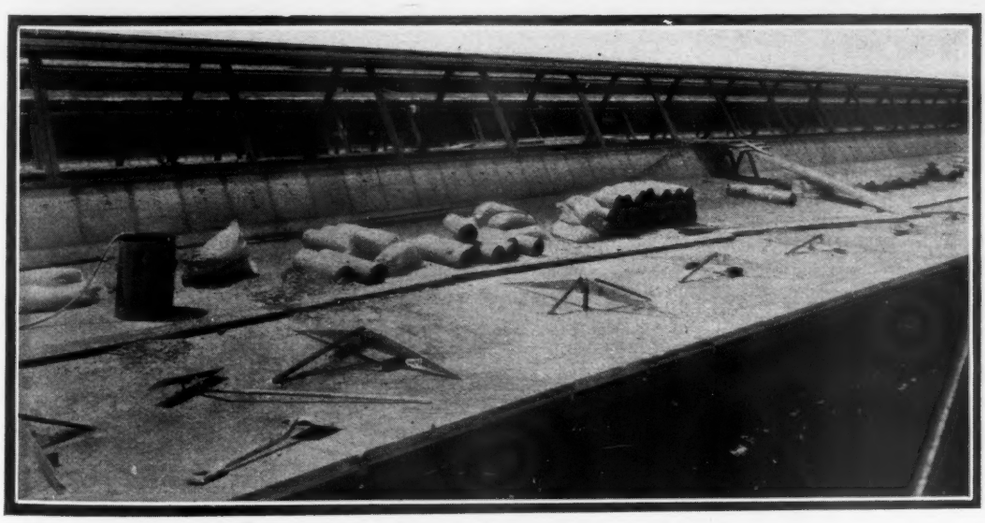
In the cable plant there are 71 unit heaters, each of which has a capacity of 414,000 B.t.u. per hour, operating on 2 lb. of steam, and handles about 5,560 cu.ft. of air per minute. The heaters in the insulated-wire building are of the same type, but the smaller size of the building requires only 31 units. The condensation from these heaters is returned to a vacuum pump and is thence pumped directly to the condensate line returning to the power house through the underground tunnel.

The three-story office portion of the cable plant is heated by hot-water radiation. The steam-heated water heater and circulating pumps are located immediately adjacent to the office section.

In so far as the shops are concerned, the advantages which it is hoped to obtain by use of unit heaters,



In areas where the roofs are high, the lighting units are suspended from disconnecting hangers, which permit the units to be lowered for cleaning or relamping. This view was taken on the loading platform of the cable plant.



Reinforced, precast gypsum blocks laid on T-rails were used for the roof deck of the cable plant.

as compared with direct radiation, are as follows:

1. The air is kept in circulation by the heater, and will maintain an even temperature in the area supplied regardless of wind conditions, although more radiation is required on the prevailing-wind side of a building.

2. Automatic control is better adapted to unit heaters than to direct radiation.

3. Lack of floor space made it necessary to suspend the heaters from the roof trusses. Direct radiation does not economically lend itself to this flexibility.

4. In the summer it is found practicable to use the blower of the heater to circulate air for ventilation.

5. A study has shown that the combined cost of installation and operation of the unit heaters is somewhat less than the cost of direct radiation.

In providing for the employee's welfare much care was taken to provide the best in sanitary lavatories and general toilet facilities. An imported Welsh tile is used for the flooring and wall paneling of the washrooms, which are generous in size and fully fan-ventilated. Tile partitions are used for the walls of the toilet rooms. Locker rooms are inclosed with steel partitions. Vitreous fixtures are used throughout, and the plumbing was installed with a care rarely found in general practice. Copper or brass pipe was used exclusively for the domestic hot water lines. Hot water for lavatories is obtained in each building by means of a heat exchanger fed by steam from the boiler house. This apparatus is placed on the roof of a toilet room in each building.

The stairs in the office section of the cable plant are concrete, with iron pipe handrails. Nonskid treads of steel with carborundum finish are used on the stair treads.

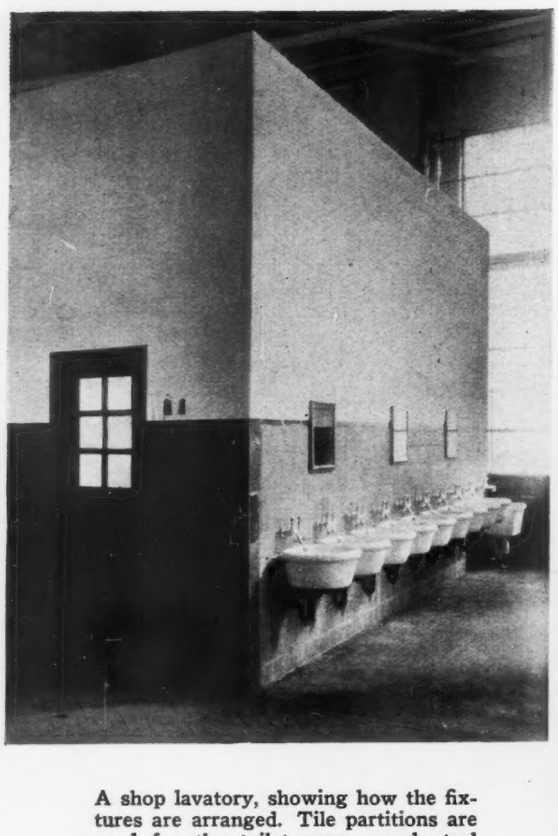
The only other stairwells are in the boiler house and in these the entire stair construction is combined structural steel and cast iron. Here, too, a nonskid tread was used for the tread member. In each case a fireproof door was placed at every landing.

In the yards all service piping is carried in tunnels, whereas in the buildings it is carried in the roof trusses. Of course, all sanitary and storm sewers and fire protection piping is carried under ground, both inside and outside the buildings.

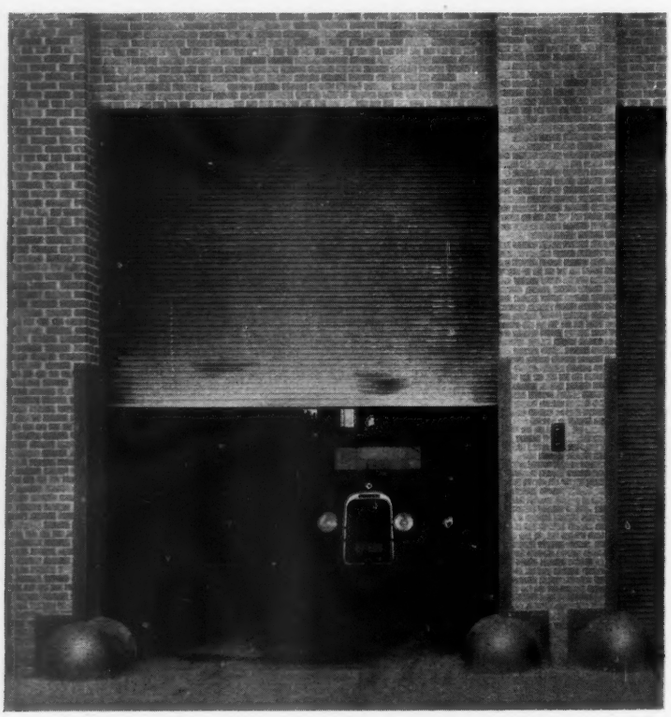
All service piping in the buildings is designated by various colored bands located just above the dado line. High-pressure steam lines have a canary yellow band; cold water and drinking water, a light yellow drab; domestic hot water, spar semi-gloss; condensate return, smokestack buff; hot water and steam heating, black; compressed air, light green; gas, azure blue; fuel oil medium brown; telephone and signal valve conduit, light blue.

Economy of space, reduction of effort in operation, and adaptability justified the use of power-operated, top-rolling steel doors in all trucking courts and interior car loading sheds.

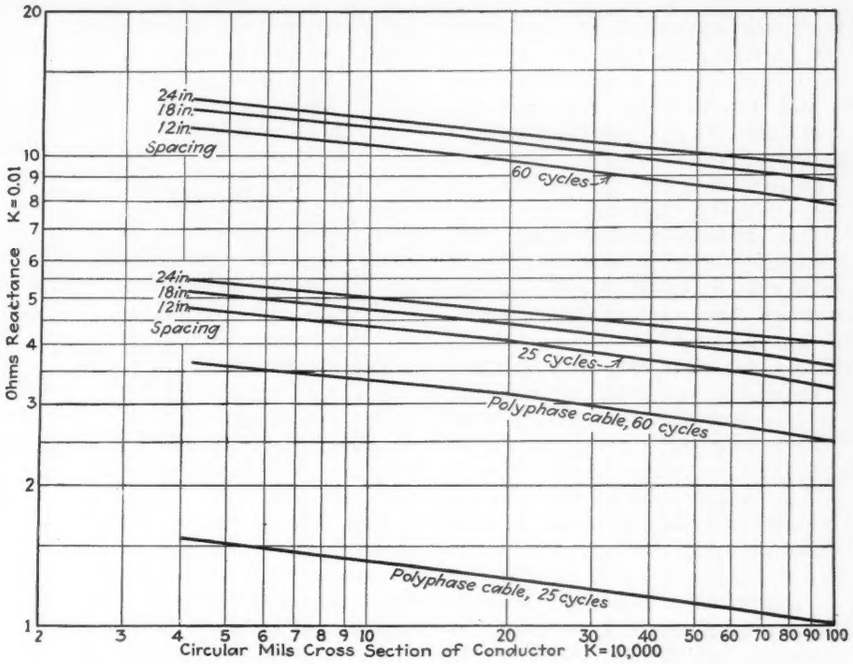
The rolling steel doors at the building end of the automobile courts are intended for use as fire doors making it possible, if a truck catches fire, to isolate it from the building itself.



A shop lavatory, showing how the fixtures are arranged. Tile partitions are used for the toilet rooms, and steel partitions for locker rooms.



Power-operated rolling steel doors are installed at the entrances to all trucking courts and interior loading sheds.



Reactance in ohms per 1,000 ft. of single stranded conductor and polyphase cable, at 25 and 60 cycles. These curves were plotted from data obtained in the G.E. laboratories.

Short-Circuit Protection on Low-Voltage Lines

B. W. JONES

Industrial Control Engineering Department
General Electric Company
Schenectady, N. Y.

TESTS were made recently on circuits carrying voltages ranging from 220 to 600 volts to determine the magnitude of the short-circuit current, and the effect of the interrupting devices. The power supply embraced 25- and 60-cycle alternating current, and direct current. Oscillograph records were made and checked against the calculated values of current to determine how much discrepancy may be expected when the approximate impedance of every element in the circuit is taken into account.

Engineers frequently estimate the current that will flow in case of a short circuit, without knowing the magnitude of the impedance in the path of the current. Little tested data have been published; hence engineers may play safe and assume that the impedance of many devices is zero. The estimated short-circuit currents may, therefore, be two or three times the actual values. An unnecessarily expensive switch is thus purchased as a logical result. In this article data will be given that may assist in determining the current that will flow into a short circuit from a low-voltage supply.

The devices in most common use on low-voltage power circuits are oil switches, disconnecting switches, contactors, current transformers, etc. The 60-cycle impedance of these devices is mostly of a reactive character. It will be close enough to consider that the reactance component of such equipment is twice the resistance component. The following representative values can be used in estimating short-circuit currents:

1. Sixty-cycle impedance of oil circuit breaker, approximately 30-amp. capacity ..... 0.001 ohm.

2. Sixty-cycle impedance of oil circuit breaker, approximately 1,000-amp. capacity. 0.0005 ohm.

3. Sixty-cycle impedance of 300-amp. disconnecting switch ..... 0.00015 ohm.

4. Sixty-cycle impedance of 1,000-amp. disconnecting switch 0.00008 ohm.

5. Sixty-cycle impedance at rated current of 10-, 100-, and 1,000-amp. current transformers may be taken respectively as..... 1.0, 0.10, and 0.0001 ohm.

Under short circuit the primary impedance of a 5-amp. secondary, 1 to 1 ratio current transformer can be estimated as a 2.5-ohm load. For higher ratios, divide this value in ohms by the square of the ratio.

6. Sixty-cycle impedance of 300-amp. contactor which carries the current through its blowout coils ..... 0.0015 ohms.

7. Sixty-cycle impedance of 1,000-

amp. contactor which does not carry the current through its blowout coils ..... 0.00065 ohm.

8. The 25-cycle impedances of the devices mentioned above may be taken as 0.58 times the 60-cycle values.

9. Reactance component of the 60-cycle impedances may be taken as 90 per cent of the impedance, and resistance component as 45 per cent.

10. The reactance and resistance components of the 25-cycle impedance may each be taken as 71 per cent of the impedance.

11. Reactance and resistance components of conductors may be taken from the table.

The reactance values for these devices are influenced by so many factors that the values given above are necessarily approximate, but close enough for the use intended here.

After the several short-circuit tests were made, these impedance values were used to check the test currents. The impedance of the entire circuit, including the generator, transformers, switching devices, conductors, etc., was determined and all of these expressed as an equivalent if put into the low-voltage or secondary circuit.

Five different test set-ups were made. One representative test from each of these set-ups has been calculated and the test value of the current given with circuit data. It is noted that the calculated value of the current always is higher than the test value. No assumptions were made to compensate for the demagnetizing action of the heavy current on the generator, and I believe that the differences can be accounted for on this basis.

Test No. 3 was the best of the group. The recording devices and the wiring were of a permanent nature. The men doing the work were experienced in short-circuit testing. Also, the resistance and the reactance of the several circuits were known.

In test No. 4 a 330-ft. length of 600,000 - circ.mil, three - conductor cable was used as a path for a short circuit on one phase of a 17,000-kva. bank of 60-cycle transformers. The secondary voltage was 600 volts. Two wires of the cable were shorted at the far end and the other two ends were connected through a 300-amp. fuse to the main bus close to the transformer. The resultant current was 24,000 amp., which was interrupted by the fuse. Test data are above.

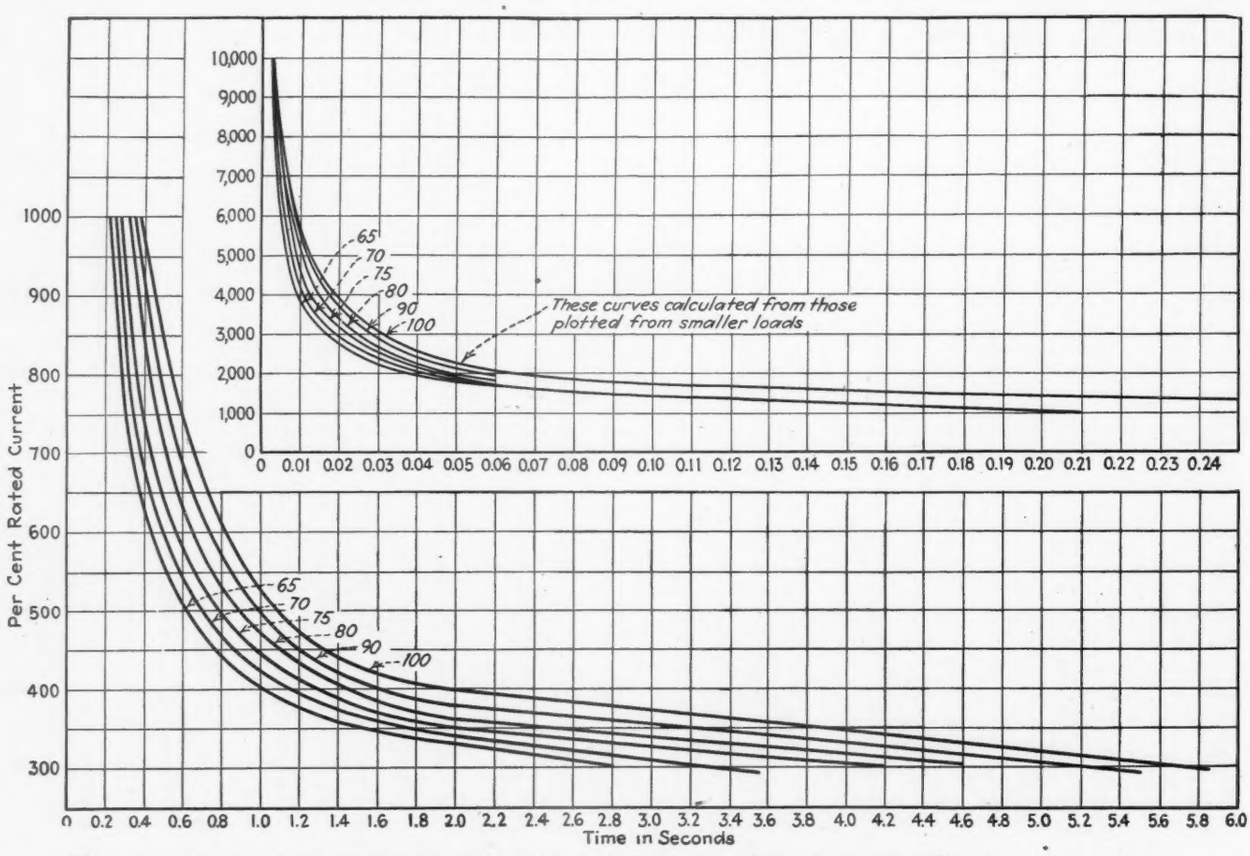
	REACTANCE	RESISTANCE
330 ft. 600,000-circ.mil cable	0.0089	0.0058
Transformer (calculated)	0.0010	0.0002
15 ft. bus, 12-in. spacing	0.0010	.....
	0.0109	0.0060

Impedance per leg $= \sqrt{(0.0109)^2 + (0.006)^2} = 0.0125$

Current $= \frac{600}{2 \times 0.0125} = 24{,}000$ amp.

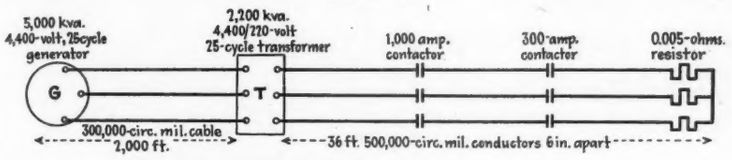
For test No. 5 complete data were not obtained on the generators or on the size of the buses, because the conditions were intended to represent a good-sized, direct-current generating system where the units are tied in at different points. Calculation of equivalent resistance would not be very simple.

A short circuit through a contactor at one point gave a current flow of 30,000 amp., and at another point on the system, close to one group of gen-



Time-current curves for 600-volt fuses under different percentages of rated current. The 65- and 100-amp. curves were plotted from test data. Curves for intermediate ratings were calculated from these data, which were obtained by the author and his associates.

TEST NO. 1



Generator has 6 percent impedance
Transformer has 6 percent impedance
To obtain the primary resistance in terms of the secondary, divide by the square of the voltage ratio.

	Reactance	Resistance
Generator	0.207 ohm	0.103 ohm
Transformer	0.470	0.236
Primary lines	0.025	0.070
Total Primary	0.702 ohm	0.409 ohm

Reduced above to equivalent of secondary values	0.00176 ohm	0.00102 ohm
Secondary Conductors	0.00088	0.00076
1000-amp. contactor	0.00027	0.00027
300-amp. contactor	0.00061	0.00061
External ohms	---	0.00500
Grand Total	0.00352 ohm	0.00766 ohm

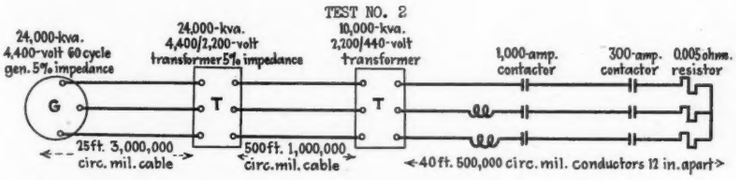
$$\text{Impedance per phase} = \sqrt{(0.00352)^2 + (0.00766)^2} = 0.00845 \text{ ohm}$$

$$\text{Resultant short circuit current} = \frac{220}{\sqrt{3} \times 0.00845} = 15000 \text{ amp.}$$

Value of current as determined by test = 12300 amp.

$$\text{Ratio} = \frac{\text{Calculated Current}}{\text{Test Current}} = \frac{15000}{12300} = 1.22$$

TEST NO. 2



	Reactance	Resistance
Generator reduced to 440 volt equivalent	0.00040 ohm	0.00010 ohm
24000-kv a. transformer-equivalent	0.00040	0.00010
10000-kv a. transformer-equivalent	0.00080	0.00020
High Voltage lines-equivalent	0.00052	0.00021
1000-amp. contactor	0.00058	0.00029
300-amp. contactor	0.00135	0.00077
40 ft. 500000 circ.mil.	0.00344	0.00080
Current transformers	0.00010	
External resistor		0.00500
Total	0.00759 ohm	0.00747 ohm

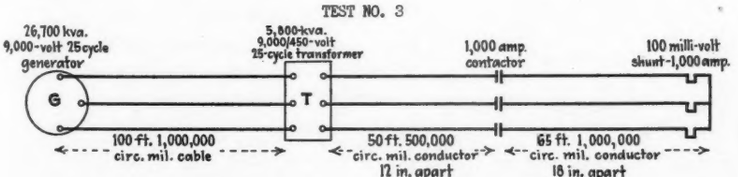
$$\text{Impedance per phase} = \sqrt{(0.00759)^2 + (0.00747)^2} = 0.0106 \text{ ohm}$$

$$\text{Calculated Current} = \frac{440}{\sqrt{3} \times 0.0106} = 24{,}000 \text{ amp.}$$

Test Current = 23,500 amp.

$$\text{Ratio} = \frac{\text{Calculated Current}}{\text{Test Current}} = \frac{24{,}000}{23{,}500} = 1.02$$

TEST NO. 3



	Reactance	Resistance
Generator (By Measurement)	0.487 ohm	0.0186 ohm
High Voltage Lines "	0.001	0.0011
Transformer 4% reactance	0.550	0.2100
	1.038 ohm	.2297 ohm

Reduced to 440-volt equivalent	0.0026 ohm	0.00057 ohm
50 ft. 500,000-circ. mil conductors	0.0018	0.00100
65 ft. 1000000-circ. mil conductors	0.0024	0.00068
1000-amp. contactor	0.0003	0.00027
1000-amp. shunt	---	0.00010
	0.0071 ohm	0.00262 ohm

$$\text{Impedance} = \sqrt{(0071)^2 + (00262)^2} = 0.00758$$

$$\text{Calculated Current} = \frac{440}{\sqrt{3} \times 0.00758} = 33{,}500 \text{ amp.}$$

Test current 30,000 amp.

$$\text{Ratio} = \frac{\text{Calculated Current}}{\text{Test Current}} = \frac{33{,}500}{30{,}000} = 1.12$$

erators, a reading of 60,000 amp. was obtained. In a similar test on the third rail system of the New York City subway a current flow of 100,000 amp. was noted.

The devices used for closing and interrupting the circuits during these tests were industrial-type contactors. They ranged in size from 75-amp. to 2,500-amp. ratings. Of course, the small contactors were used to interrupt the smaller currents. Instantaneous overload relays were used to interrupt the energizing coil circuit of the contactor following a short circuit.

When estimating the magnitude of short circuits, it is advisable to include the circuit back to the generator. The impedances can easily be reduced to an equivalent impedance in the low-voltage side by dividing the high-voltage impedance by the square of the voltage ratio.

The current flowing into a short circuit from a low-voltage, alternating-current source of capacity comparable to those under test or smaller probably will not exceed 30,000 amp. For the average industrial installation the current very likely will be less than half of this value.

If the source of power is direct current and the capaciy about the same, then we may expect currents about double those that would be obtained from an alternating-current source.

If contactors are to be used for interrupting the short circuit, there are certain limitations that should be observed. A small contactor, such as 75-amp. rating or less, should not be asked to interrupt a short circuit, because its thermal capacity is too small and it does not have a space factor large enough to handle the arc. The next or 150-amp. size of contactor may interrupt short circuits on systems that will not deliver more than 10,000 amp., providing the contactor is in the open. If the contactor is in an inclosing case, the case should be lined where the flame will strike it.

Contactors of the 300-amp. size or larger have sufficient thermal capacity to carry short-circuit currents long enough to enable them to interrupt such currents before the shunts melt. Also, the arcing horns are long enough to allow the arc to stretch a sufficient distance to interrupt itself without reaching parts which it should not reach. For these reasons a 300-amp. contactor is large enough to have good interrupting capacity.

As contactors increase in rating above the 300-amp. size their thermal capacity and arcing space factors increase, but the speed of movement diminishes. This is a detrimental

RESISTANCE AND APPROXIMATE REACTANCE OF CONDUCTORS

Size in Circ. Mils	Resistance, Ohms per 1,000 ft.	Reactance per 1,000 Ft. at 60 Cycles — 24-In. Spacing Ohm	18-In. Spacing Ohm	12-In. Spacing Ohm	Three-Conductor Cable Ohm
41,740	0.2533	0.13	0.12	0.115	0.037
52,630	0.2008	0.13	0.12	0.11	0.036
66,370	0.1591	0.125	0.115	0.11	0.035
83,690	0.1262	0.12	0.114	0.105	0.034
105,500	0.1003	0.118	0.113	0.104	0.033
133,100	0.0794	0.115	0.110	0.101	0.032
167,800	0.0630	0.113	0.108	0.100	0.032
211,600	0.0499	0.112	0.105	0.093	0.031
250,000	0.0423	0.11	0.103	0.094	0.031
300,000	0.0352	0.106	0.10	0.092	0.03
400,000	0.0264	0.104	0.098	0.089	0.029
500,000	0.02114	0.102	0.096	0.086	0.028
750,000	0.0141	0.098	0.091	0.082	0.026
1,000,000	0.01057	0.095	0.088	0.078	0.025

(The reactance values for 25 cycles are $\frac{5}{12}$ of those given in the table)

factor, but it may be overcome by adding a series auxiliary to force the contactor open.

To protect small contactors and motors, such as the 75-amp. and in some instances the 150-amp. size, fuses with a rating of four times the motor current rating should be used. Fuses of this size will not interfere with the normal functioning of a motor, but as shown in test No. 4 they will interrupt currents up to at least 25,000 amp., 600 volt, which is more than is likely to pass through small contactors. Also, this interruption will take place in approximately one-half cycle, or 1/120 second, which is fast enough to protect small devices from overheating. The accompanying curves show the time required for fuses to open a circuit under different loads.

■ ■

Westinghouse Lighting Institute Acquired by the Electrical Association of New York

THE ELECTRICAL Association of New York has acquired the Westinghouse Lighting Institute in Grand Central Palace, effective Oct. 1, 1931.

This acquisition was made possible by the generosity of the Westinghouse Lamp Company who offered to contribute its institute, without cost, in carrying forward the cooperative industry program of the association. In speaking of the intended purposes and scope of the new institution, which will hereafter be cooperatively maintained and operated as an industry, educational, and market development center by the association, Mr. Law, its president, said:

"This, the Electrical Association of New York, is venturing upon a comprehensive program that will include educational, market development and sales activties in which every element of the membership can participate. The nucleus for these activities will be the Association's Electrical Institute.

"This institute immediately provides a center of local, national, and even international reputation, deservedly acquired through its previous notable educational and promotional lighting activities.

"Supplementing the present extensive lighting exhibits and demonstration of the Institute, other applications of electrical uses will be added gradually, so that ultimately the institute will incorporate exhibits and demonstrations, whenever practical, of electricity's every use in industry, commerce and the home. Thus, visitors interested in any particular field of electrical application may view all of the uses in that field and receive the advice or information they may be seeking. Lectures and demonstrations can be given to apply specifically to the electrification needs of any group.

"The enthusiasm and support that has been displayed and pledged toward this movement by the central station, manufacturer, wholesaler, contractor and dealer groups of the association is indicative of their combined objective—that of ever better and more complete public service. To this, the membership of the association dedicates the Electrical Institute of New York. It is their hope that it may serve, and serve well, both locally and nationally.

"Ralph Neumuller, former director of the Westinghouse Lighting Institute, and for many years closely identified with the electrical industry of the metropolitan area in advertising and merchandising capacities, will assume the managing directorship of the association, supervising both its market development and Electrical Institute activities."

■

Six New A.S.A. Safety Codes

THE AMERICAN Standards Association has just approved a group of six safety codes, five of them for the prevention of dust explosions in industry. One of the codes provides for the use of inert gas for fire and explosion prevention.

The codes, which were prepared by the sectional committee under the sponsorship of the National Fire Protection Association and the U. S. Department of Agriculture, are:

Safety Code for the Installation of Pulverizing Systems for Sugar and Cocoa (Z12b-1931)

Safety Code for the Prevention of Dust Explosions in Starch Factories (Z12c-1931)

Safety Code for the Prevention of Dust Explosions in Terminal Grain Elevators (Z12e-1931)

Safety Code for the Prevention of Dust Explosions in Wood Flour Manufacturing Establishments (Z12g-1931)

Safety Code for the Prevention of Dust Ignition in Spice Grinding Plants (Z12h-1931)

Safety Code for the Use of Inert Gas for Fire and Explosion Prevention (Z12i-1931)

The Safety Code for the Use of Inert Gas for Fire and Explosion Prevention provides for the dilution of the air in inclosures in which flammable liquids, dusts, or vapors are handled, so as to reduce the oxygen content of the air to a point where combustion cannot occur. The code includes a table of the maximum permissible oxygen percentage for various flammable substances, and provides for the use of flue gases, carbon dioxide, and other inert gases.

AROUND the WORKS

A section devoted to short articles describing practical methods devised to meet specific operating conditions. The items may refer to details of installation, inspection and testing for maintenance, wiring, repair, and replacement.

◆

Protecting the Vee Rings

IN SMALL and medium size direct-current motors and generators it has always been a problem of how to protect the front vee rings of the commutator and the cord band at the rear of the solid neck commutators.

Oil and dirt, and so on, have always given trouble when they found their way into the front vee rings or on the front surface of the commutator, yet there are a number of different methods of insulating surfaces exposed to dirt, oil, moisture, flashover, etc., to minimize their ill effects.

The following method has been found to give good results and is based on the use of a compound that has red oxide for its base. The color ranges from a dull to a bright red, depending upon the percentage of the basic material and amount of shellac used as a solvent.

The higher the red oxide content, the better it will resist oil, acid, moisture and dirt, and it will not blister or peel when exposed to heat. The best grades will machine without crumbling or cracking.

The best method of insulating the front mica vee rings of wound armatures is as follows:

1. Clean the mica vee ring, using sandpaper to get a good smooth, hard, clean surface.

2. Paint this surface with a good grade of orange shellac.

3. Apply a string band while the shellac is still tacky. The best material for string bands is a soft flexible small diameter twine, such as flax or Italian twine. The bands, however, should be applied tight.

4. Apply a good coat of orange shellac. To obtain a smooth hard surface, a hot iron can be used to iron out the shellacked band. The ironing seals down the nap and fills the hollow space between the turns of the cord.

5. Two or more well-ironed coats of shellac should be applied until a hard and smooth surface is obtained.

6. Apply two or three coats of the red oxide compound, allowing each coat to air dry.

When using the red oxide, paint the front of the commutator bars up to the brush surface and make a small fillet of the compound at the intersection of the bars with the vee ring. This method gives maximum protection from oil, steam, acid fumes, etc., and is well worth the time expended.

The following, however, is a quicker method and will be found satisfactory for average conditions:

Clean the vee rings, and shellac as heretofore mentioned. Apply the cord band and give it one coat of orange shellac, then let it air dry. Paint on one coat of the red oxide compound, covering the front of the bars and vee ring.

This last mentioned method can also be used for the rear vee ring before rewinding.

When a cord band is placed back of the commutator neck, over the leads of wire wound coils, or if a cord band is used to hold a hood in place, the cord band and top of the commutator necks can be painted with two or three coats of the red oxide compound, letting it run into open spots to seal all openings against entrance of dirt, etc.

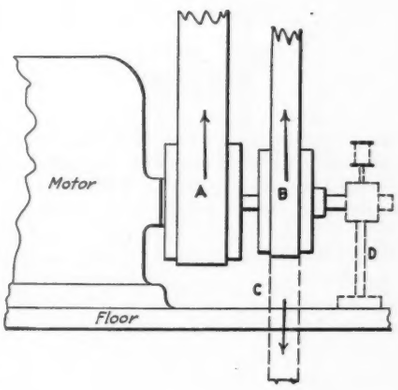
Wilkinsburg, Pa. A. C. ROE.

■

A Remedy for Overloaded Motor Bearings

I RECENTLY had the job of inspecting a chocolate factory with instructions to report on the reasons for the low productivity of certain machines driven by electric motors. Although some of the clarifying, mixing, extracting, and wrapping machinery was antiquated, the electric motors were of modern design and apparently in good condition but, in some cases, overloaded.

One motor, which was furnishing the power for two countershaft drives in the manner shown in the drawing, had been overhauled by the factory machinist who added a pulley next to the regular motor pulley to accommodate a second belt. Both of these belts, indicated by *A* and *B*, pulled in the same direction. Because this condition had not been anticipated by the builder of the motor, no provision had been made



to cope with the increased strain on the bearings which, of course, were overloaded. An excess of oil was applied to the bearings to keep them from overheating, but it merely smeared the parts and the floor with greasy deposits. The obvious remedy was to remove the surplus belt *B*. Also, the pull of the shaft could have been equalized fairly well if the outside belt has been arranged to pull in the opposite direction, as indicated by the dotted position at *C*. Because such changes were not feasible, a compromise was made by allowing the belt *B* to run as before and installing an outboard bearing at *D* to relieve the strain on the shaft and motor bearings.

Palo Alto, Calif. GEORGE RICE.

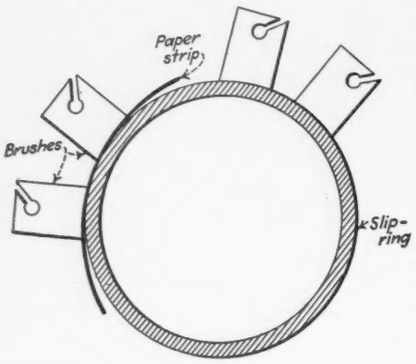
■

Care of Motor Brushes

CUT A STRIP of cardboard between 0.02 and 0.035 in. thick, 4½ in. wide, and 12 to 14 in. long. Place the cardboard under one or more brushes and work it back and forth, keeping it bent around the commutator or slipring. The accompanying sketch shows how the cardboard is applied to a slipring motor. When working on a slipring motor, the job is done while the motor is running because this procedure helps to keep the sliprings clean. The cardboard not only will pick up any loose dirt or carbon on the face of the brushes but also will smooth the brushes unless they are badly cut. I seldom use sandpaper but, should it become necessary to

do so, I follow its use with the above procedure.

I have about 40 motors and generators under my care and, since I have been using this method, have had little trouble



from sparking. Among these machines are five portable welders, which frequently have been operated in locations where dusty and gritty conditions exist. After nearly five years' service, the commutators still have a true surface and are in excellent working condition. During this time it has not been necessary to turn the commutators or to perform other mechanical work on them.

I obtain an average of about four and one-half years' service from my brushes and consider this record hard to beat.

W. P. HARRINGTON.

West Tulsa, Okla.

■

Method of Obtaining Good Ventilation Despite Strong Cross-Currents

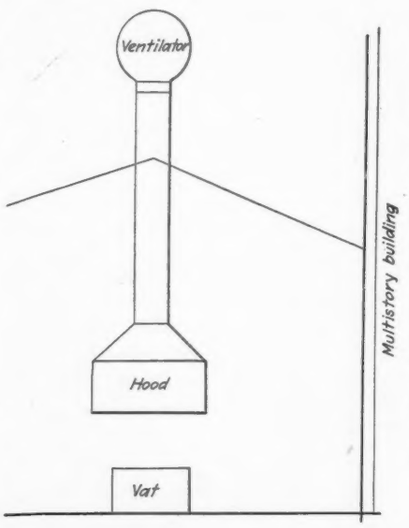
REMOVING smoke and fumes from a large vat in a manufacturing plant where there are strong cross-currents is often a difficult problem. The smoke diffuses over the room almost instantly, so that the entire volume of air of the room must be removed. This displacement of air results in the loss of considerable heat.

A large oil-quenching vat in a single-story building adjacent to a multistory building threw off large volumes of smoke. This smoke was caught by one cross-current coming from an areaway between the structures when the windows of the smaller building were open, as well as by another cross-current which traveled from the single-story building to the multistory building through open doorways. As a result, the entire air volume of the large building often was contaminated by the smoke.

The first effort at ventilation was to install a 30-in., gravity-type, turbine ventilator on the roof of the single-story building. This attempt failed, obviously because of the cross-currents existing within the building due to the impracticability of keeping the doors and windows closed at all times.

A study was made of the cross-currents with the aid of an anemometer. The air velocity through the door was 130 f.p.m. and, at the edge of the quenching vat, it was 154 f.p.m. The air velocity in the 30-in. square duct of the ventilator described in the preceding paragraph was 132 f.p.m. If the smoke had been allowed to rise to the roof of the building, this ventilator would have removed it. However, with a cross-current stronger than the air current induced by the ventilator there was no hope of success.

Obviously something had to be done to intercept the cross-currents and to keep them from interfering with the removal of the smoke. The procedure was to drop a sheet-metal hood over the vat and to connect the turbine duct directly to the hood, as shown in the sketch. The hood was made to clear the floor by 6½ ft. to provide headroom. Checking the velocity of the smoke current directly above the vat showed it to be slightly stronger than the cross-current, therefore the hood would envelop the smoke before the cross-currents could spread it over the building. After this installation, all smoke was removed except a very small portion, which escaped around the lower edges of the hood.



H. C. CHARLES.

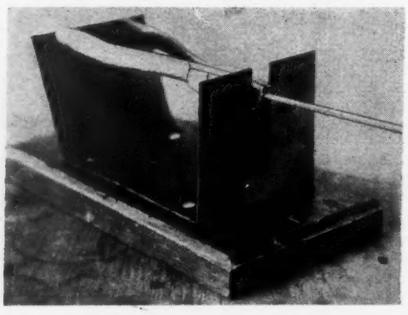
Waterloo, Ia.

■

Plier Holder Facilitates Repair Jobs

MANY maintenance jobs require the use of pliers to hold pieces of metal while they are being heated for soldering or hardening purposes. In performing such jobs, I have found that the use of a plier holder expedites the work because it leaves the hands free for other work and eliminates the tiresome task of holding the pliers.

The holder is composed of sheet metal



with a cast-iron base. A slot is cut in the top of one end, and the strip of metal resulting from the cut is bent outward as shown to form a support for the work held in the pliers. The other end is tapered so that the pliers and piece may be placed in the holder as illustrated by applying a slight pressure. This operation locks the jaws of pliers tightly against the piece, yet the pliers can be lifted out easily.

Hamilton, Ont., Canada H. MOORE.

■

Ejector for Sewage Drainage

IN the September issue of *Maintenance Engineering* there appeared an article, "Ejector for Sewage Drainage," describing a device applied to a basement. The sketch was somewhat out of proportion and, therefore, may have mislead anyone attempting to use it.

For such work there is listed an ejector tee, which would do the job more efficiently and economically. This device, shown in Fig. 1, will operate on city water pressure and can be fitted with a float-operated valve, so that it will operate automatically in any house cellar.

Where this special ejector tee is not available, an efficient device, shown in

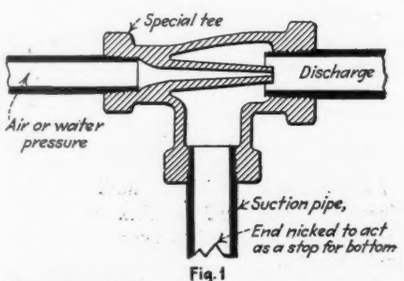


Fig. 1

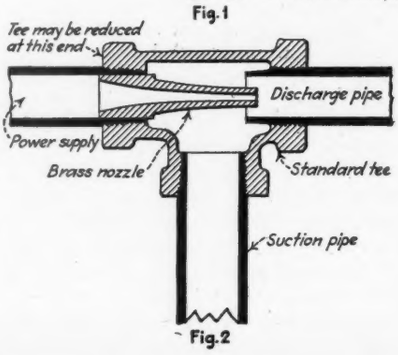


Fig. 2

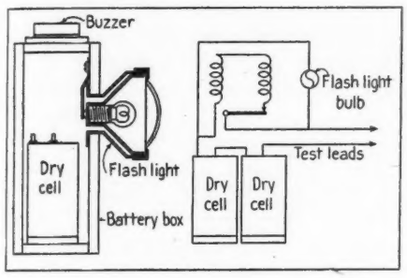
Fig. 2, can be made by using a standard tee equipped with a nozzle fitted into the water-supply end as shown. It will be advisable to use brass jets so that rust will not clog the nozzle.

JAMES MCINTOSH.
Cleveland Heights, Ohio

■

Test Set With Audible and Visible Signal

OFTEN while testing or tracing circuits with a buzzer testing outfit consisting of two No. 6 dry cells and a buzzer, it is very difficult to detect the sound of the buzzer amid such other noises as the pounding of pneumatic hammers, and so on. One method of overcoming this difficulty is



to make the test set visible as well as audible in its indications.

An outfit of this sort which we use consists of a flashlight bulb and reflector mounted on the side of the battery box, which is constructed of wood, with the buzzer mounted on one end. The bulb is connected in parallel with the buzzer.

EMMET W. NASH.
Cleveland, Ohio.

■

Modern Drive Features Short Power Tables

APPLYING a small motor to a power table frequently presents a difficult problem. The accompanying illustration shows a series of power tables placed at right angles with the windows of the building, as contrasted to the usual method of construction which is to install the machines parallel to building length. This method frequently entails the installation of larger motors which are supported on the walls of the structure. The cross method of installation is more satisfactory, as it divides the machines into smaller groups, provides flexibility and allows the foreman to come closer to the operators.

Driving these power tables is accomplished in the following manner: The motor is attached to a support located on the floor. The shaft is driven by means of an inclosed chain drive running in oil.

Ball bearings are used on all shafting

Power tables placed at right angles to windows offer advantages in respect to drive and foreman supervision

to reduce the friction load, also vibration. The entire equipment is thoroughly guarded to prevent acidents. The motor is controlled from an oil switch supported under the bench as shown.

This method of operation has proven extremely satisfactory and has been in use for many years without the renewal of motors, chains or control equipment. It is believed that the short bench located in this manner furnishes better working conditions and better light than the plan of running long tables parallel with the building.

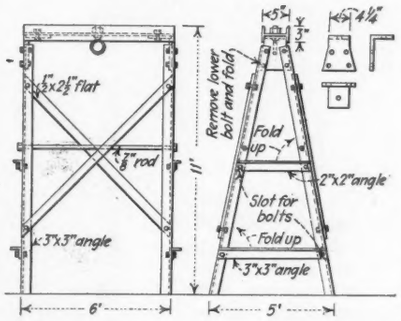
K. D. HAMILTON.
Mechanical Department
Geo. E. Keith Company
Campello, Brockton, Mass.

■ ■

Portable Erecting Frame

A PORTABLE erecting frame for use in taking down or installing flywheels, turret heads, spindles, and other heavy parts encountered in repair work can be made from steel angles and flats as shown.

The four end uprights are made of 3x3-in. angles. Side and end braces are made from 2x2-in. angles, 3x3-in. angles, and $\frac{1}{2}$x2$\frac{1}{2}$-in. flats as shown. The two $\frac{7}{8}$-in. truss rods are turned down and threaded to a $\frac{5}{8}$-in. diameter at the ends. The top cross member, to which the chain hoist is attached, is made of a 5-in. I-beam. It is attached to the forged plate at each end of the frame by two $\frac{5}{8}$-in. machine bolts.



To erect the frame the uprights are opened to take the braces, and the top bolts are put in place and tightened. The tierods are next put in place, after which the I-beam is installed at the top and, finally, the diagonal flats are bolted in place. A blueprint always should be kept with the frame so that the erecting gang will have no trouble in assembling it.

This frame has a capacity of at least a half ton and can be erected in an hour or less by two men. Its use eliminates the necessity for the erection of scaffolding for holding chain hoists.

WM. C. BETZ.
Master Mechanic
Fafnir Bearing Company
New Britain, Conn.

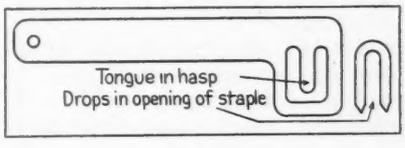
■

Door Hasp With Locking Feature

ONE of the drawbacks of the ordinary door hasp is that it is not a convenient locking device. Also, it is only a temporary affair. A type of hasp that has proved to be more satisfactory for the purpose intended is shown in the illustration.

It is made from $\frac{1}{8}$-in. flat iron, cut out as shown. The opening at the lower section of the staple end allows the hasp to slide over the staple. In dropping the hasp in place, the tongue enters the staple where it is retained by the weight of the hasp.

R. M. THOMAS.
Denver, Colo.



LUBRICATING SYSTEMS

(Self-Contained Types)

FRED H. LOW
Mechanical Engineer

Ninth article of a series. The next will appear in an early issue.

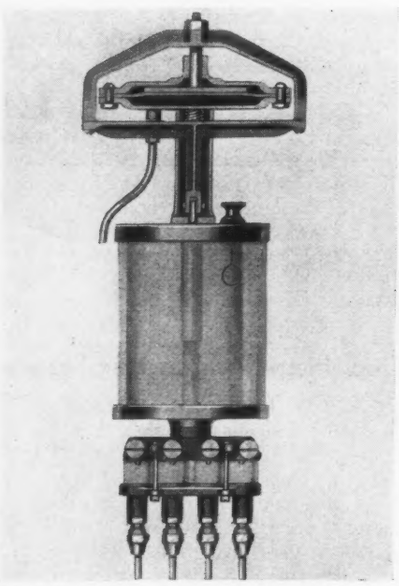
WHERE oil cups are used on remote, intermittently operated, self-starting and -stopping equipment, such as bilge pumps, well pumps, compressors, and the like, a self-opening and closing oil cup as shown in Fig. 61 will prevent the wasting of the oil while the equipment is not in operation.

Normally, the needle valve rests on its seat but, when the pressure in the main delivery line of the pump or compressor builds up, it acts upon the diaphragm which causes the needle valve to be lifted from its seat. The cup shown has four sight-feed outlets, each of which is independently regulated by screw valves located in the base casting just above the sight-feed glasses. While this unit is pressure operated, there is no doubt that it could be equipped for electrical operation which would permit its use on a greater variety of equipment.

In place of using single-feed cups, tanks with several feed outlets, as in Fig. 62, frequently are used. Each outlet of the sight-feed type is controlled by an individual, adjustable needle valve, having a quick-opening and closing device. A glass window is placed in the end of the tank so that the level of oil may be easily noted; however, in some types of tanks a gage column is used for oil-level determination. There are other makes in which a float-type indicator is used.

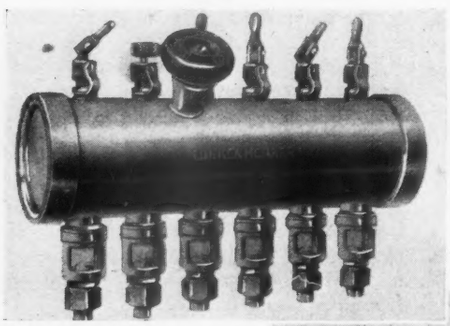
Multiple oilers of the sight-feed type are also made for operating under back pressure, as already described.

The lower unit in Fig. 62 can be operated by a solenoid, electric motor, link connections to the machine being lubricated, or by hand. Air supply can be taken from service lines through the medium of a reducing valve to bring the pressure down to 30 lb. per sq.in., or a small electrically driven compressor unit can be used. The air is not used to force the oil through the lines, but

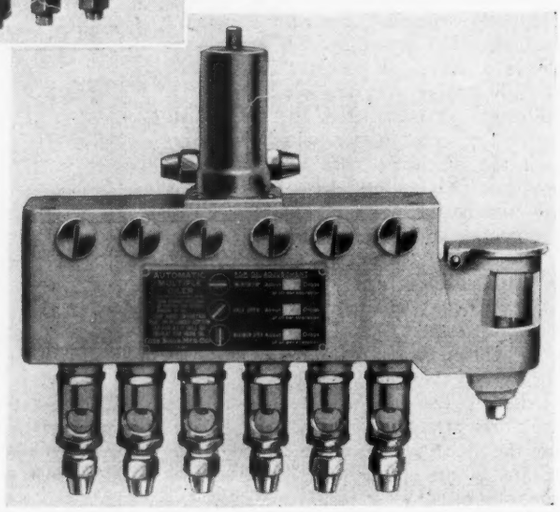


Courtesy Yoemans Brothers Company

Fig. 61—Gravity, sight-feed lubricator which opens when the pressure builds up on the delivery line of the pump or compressor that is being lubricated.



Courtesy The Lunkenheimer Company



Courtesy Gits Bros. Manufacturing Company

Fig. 62 — Gravity multiple-feed oilers. Only one of the units shown is equipped with regulating valves.

merely performs the single mechanical action necessary to transfer the oil from a well to feed glasses. Whether this action is accomplished by an air piston, solenoid, or geared motor, a separate timing device is required suited to each type, but the timer may be omitted if the oiler is operated manually.

These timing devices can be set to operate the oilers at intervals of 6, 12, and 24 min. or up to any interval that is necessary. In cases where three or four oilings a day are sufficient, hand operation is preferable. The timers can be driven by small electric motors or can be belted to the machine being lubricated.

Essentially, the unit consists of a piston and plunger with a cross bar to which six oil cups are attached. Ordinarily these cups rest in the bottom of a well of oil, but at selected intervals the crosshead is raised by the air piston to a fixed height and a quantity of oil in each cup is discharged through standpipes directly connected to sight feed glasses below which the connection is made by tubing to the various bearings. By means of adjustable sleeves with slotted ports surrounding these standpipes, the amount of oil fed can be controlled within close limits. Adjustment of each individual sleeve is made by a collar engaging a crank pin in the end of a solid stud. These adjusting studs turn easily and can be set by a coin or screw driver applied to the slotted head exposed on the front of the body. The timing device can be set so that the cups are held in the discharge position an interval proportional to the viscosity of the oil, allowing complete drainage at the selected port level.

Obviously, these gravity tanks must be located above the highest point at which the lubricant is to be applied. Oftentimes it means that the tank must be located at a height which is inconvenient for the operators, not only for filling, but also for adjusting the feeds in the valve type. In such cases the tank may be installed in an elevated position, with a main pipe and distributing branches, sight-feed fittings of the valve type, Fig. 63, being installed at a convenient point in each bearing lead or in headers. The tank can be of such capacity, or located on the floor above, so that filling it requires little effort. Adjustment is made at a point convenient to the operator.

Units of this kind are designed to meet various requirements of piping system, quantity of oil to be handled,

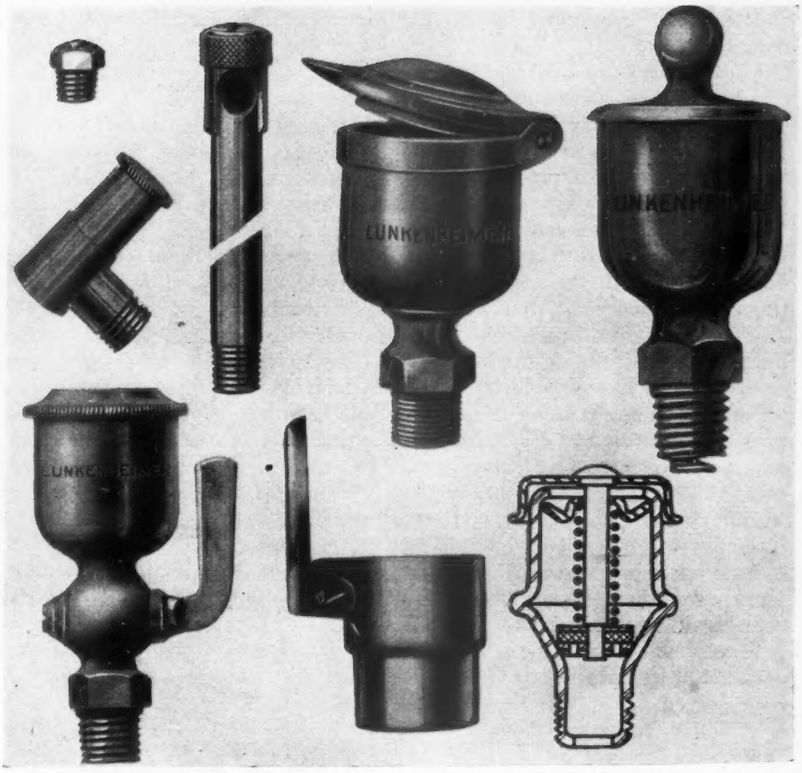
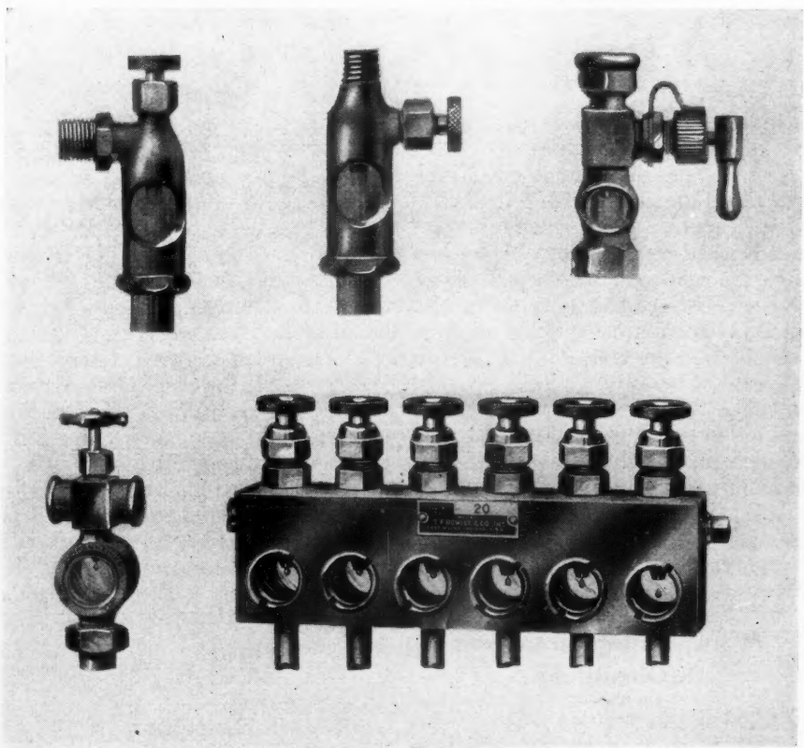


Fig. 63—Sight-feed oilers without supply tanks.

Courtesy Bowen Products Corporation, The Lunkenheimer Company, and Rivett Lathe & Grinder Corporation



Courtesy S. F. Bowser & Company, Inc., and The Lunkenheimer Company

Fig. 64—Oil cups of various types used where no central system is furnished.

and the pressures under which they operate.

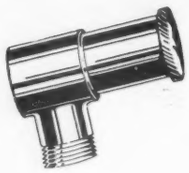
Multiple feeds of different designs, one of which is shown as a six-feed oiler in Fig. 63, may be procured, or headers can be made by drilling and tapping a section of pipe into which individual fittings may be inserted.

Some installations have been made where air pressure is utilized to deliver the oil to the sight-feed fittings and thence to the bearings. Also, in some instances the oil is pumped, either through a dead-end or loop pipe line in which a relief valve is used to maintain the desired pressure. In this way it is possible to make rather extensive installations using this equipment. As the quantity of oil consumed is small and very little pressure is required to deliver it, small pumps driven by fractional horsepower motors make this a very economical application.

Small all-metal cups, which in some instances are little more than a cover for the oil hole, are sometimes used either to save expenses or because they are best suited to the conditions. There is a wide variety of such cups offered, most of the development work having been done before the days of the application of central systems to machine tools and automobiles. Today they find their greatest use on trucks, farm machinery, household devices, small shop tools, and machine tools which are not furnished with a central lubricating system.

A group of these oilers covering several types is shown in Fig. 64. Practically all of the fittings are made in both angle and straight types, with male or female thread, while many of the smaller ones are made with a drive shank. They vary principally in size and the manner of covering the hole. Some covers are hinged, others are of a self-closing design, while a few are of the screw type.

It is usually advisable to select oilers of a type having the cover secured to the cup, which prevents the covers from being lost. Furthermore, the self-closing types are more likely to keep out the dirt as the others are often left open owing to the carelessness of the operator. Unless broken oilers are replaced at once, the advantage of the self-closing feature is lost. It is desirable, therefore, to put sturdy equipment on important or frequently lubricated bearings.



The cup with cross-section shown in Fig. 64 is designed to facilitate filling. It is of the self-closing type, the flange of the cover extending well down the side of the cup to prevent dust or grit settling on the edge of the filler hole. The flanged cap or cover is designed so that it is easily raised by means of a wedge-shaped device attached to the spout of an oil can.

Although some oilers are so small as to provide little or no storage, those of larger size are usually provided with a piece of felt or waste to retard the flow of oil. It also acts as a filter to a certain extent. Some of the cups are provided with wick leads which in some cases act simply to restrict the flow of oil.

Concerning the Locker Problem

AFTER reading the comment made by Mr. Schwabe on his experience with metal lockers and on their corrosion in the presence of chemical fumes, I though that in his case there was an opportunity to use one of the recently developed lead-spraying guns to advantage. These guns take lead wire, melt and atomize it, and spray it onto a steel surface to a thickness of about 0.004 in. The purpose is to make the steel surface corrosion-resistant. Offhand, it seems that manufacturers of steel locker equipment might do well to offer lockers sprayed with lead for places where chemical fumes are to be reckoned with.

Wood lockers have fallen into considerable disfavor because they are combustible, but one remarkable fact about them remains: Wood is a very poor conductor of heat and as a result wooden lockers will protect their contents in case of fire until they have burned entirely through. Moreover, remarkable advances have been made of late in the matter of rendering wood fireproof. Therefore it seems possible that wood may stage a comeback as locker material. Chemicals forced into wood render it non-combustible. Some chemicals of this sort are known under the name of Arclor, and are obtained by adding chlorine in various amounts to diphenyl.

Still another development is plywood with metal faces. Here we have the non-combustibility of metal plus the non-conductivity of wood. Such plywood is being made successfully both in the United States and in England. Lockers of this material would, of course, be more expensive and might therefore be adaptable only to such places which require the utmost in protection.

Peoria, Ill. JOHN E. HYLER.

■

A Lumberman on Lockers (Discussion)

I HAVE just read an article in the current issue of your publication, which I do not think should have a place in a trade magazine. I refer to "Lockers—A Plant Asset."

Calling attention to the desirability of a locker installation is well worth while, but I do not see why the author should go on and cite the supposed advantage of one basic material over another. He quotes comparative prices between an article built by local hand labor and a factory product, and does not give comparative designs. The author further states that steel lockers are fireproof. If the clothes inside caught fire, I wonder how the steel lockers would prevent them from burning up; or if the building itself caught fire, does any one attempt to say that a sheet-steel locker would prevent its contents from being consumed, or that the lockers would be of any material use after going through a fire?

The gist of this letter is that an article of this kind should not draw general comparisons between the advantages and disadvantages of our basic materials. E. E. MARTIN.

The Booth-Kelly Lumber Co.
Eugene, Ore.

■

Correction

IN THE article entitled "Capacitor Single-Phase Motors," by L. T. Campey, beginning on page 427 of the September issue, Figs. 1 and 2 were inadvertently transposed.

In the third column, eighteenth line, on page 430, reference should have been made to Fig. 7, instead of Fig. 8, as given.

Power Losses in Group Drives

ROBERT W. DRAKE
Mechanical and Electrical Engineer
Chicago, Ill.

PART II

IN THE preceding article, in the October issue, the value of the friction losses in lineshaft-hanger bearings was discussed. This article takes up an analysis of other sources of power loss, some of which commonly have been included in the hanger-bearing losses.

Countershaft-Bearing Friction

Friction in sleeve-type countershaft bearings may be expected to be somewhat less when machines are running than when they are idle; for loose pulleys are seldom as well lubricated as hanger bearings. When ball-bearing loose pulleys are used with sleeve-bearing hangers, the opposite is likely to be true, unless the belt drags on the tight pulley.

Countershafts are frequently purchased with the driven machines. Hence, there is a great variety of styles and types of countershaft bearings in most shops. After listing and considering such bearings individually in several analyses, we found that the total countershaft-bearing friction amounted to about twice the friction in the lineshaft hangers. We use that assumption when approximate results are sufficient, and where countershaft bearings are of the same general type (sleeve or anti-friction) as the lineshaft hanger bearings.

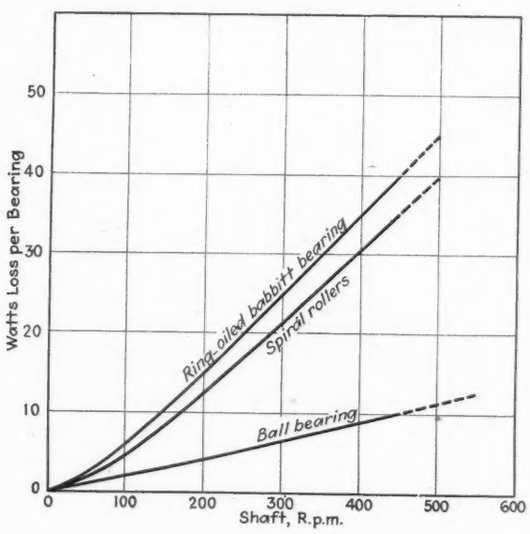


Fig. 1 (Right) — Friction losses from University of Wisconsin tests by Thomas on $2\frac{7}{16}$-in. lineshaft-hanger bearings fitted with ring-oiled babbitt, ball, and spiral-roller bearings. Bearing loads ranged from 710 to 730 lb. The temperature for each point on the chart is the average operating temperature for nine-hour-a-day operation, higher for the higher speeds, and lower for the lower speeds.

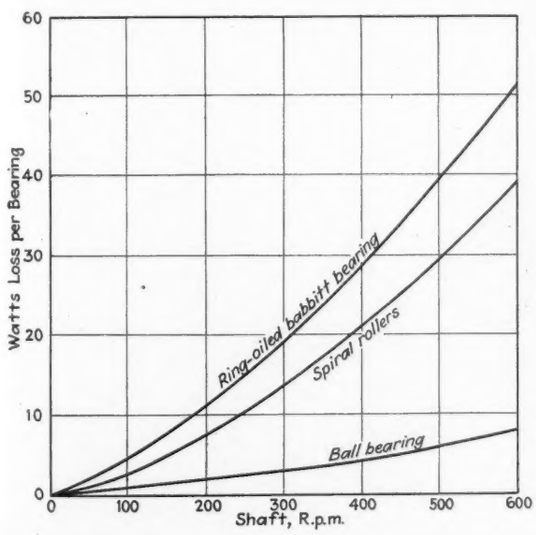


Fig. 2 (Left)—Friction losses, babbitt, ball, and spiral-roller bearings, extrapolated from University of Wisconsin tests for bearing loads of 210-240 pounds.

Friction in Lineshaft-Hanger Bearings

The University of Wisconsin tests by Thomas, Figs. 1 and 2, determined the comparative performance of ball, roller, and babbitt lineshaft bearings under ideal conditions. These data are extremely valuable, for all variables were eliminated or accounted for; but they cannot be used directly in estimating the friction loss of lineshafts in practice. The results are invariably too low, because windage losses are not included. However, these tests furnish the most reliable comparison available of the relative losses in the three types of bearings when operating conditions are perfect. The following points should be noted:

1. The tests were run on $2\frac{7}{16}$-in. shafting and bearings. Loads per bearing ranged from 700 lb. to over 1,700 lb. As lineshaft bearings of this size average decidedly less than 700-lb. load each, it is necessary to extrapolate Thomas's results to compare them with practical test results.

The tests at higher loads indicate the possibility of applying extreme loads without overheating or bearing failure; but to date practice has not tended to the use of hangers close together, or to extreme loads on small shafting.

2. Thomas's tests extended to speeds at that time considered high (450 r.p.m.) for $2\frac{7}{16}$-in. lineshaft.

3. Slight misalignments that are

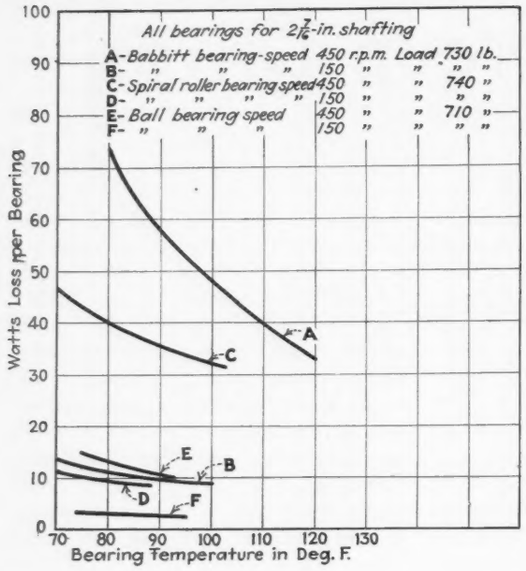


Fig. 3 — How lineshaft-bearing friction varies with the temperature when different types of bearings are used.

unavoidable in lineshafting were entirely eliminated in these tests; a flexible coupling was installed between every pair of bearings.

These tests showed many interesting things. First, the friction of babbitt and roller bearings varies so much with bearing temperature that tests neglecting this fact cannot be expected to agree among themselves or with other tests. Roughly, the data shows that the friction load on a high-speed or heavily loaded lineshaft with plain bearings may decrease 50 per cent (See Fig. 3) during the first four hours of operation, because of the decrease in oil viscosity as the bearings warm up. This effect is less with roller bearings, and far less with ball bearings.

All friction loads discussed here and compared with Thomas's tests will be the friction after approximately 3¼ hr. running. Friction decreases somewhat after this, but this basis gives a fair average friction for a 9- or 10-hr. day. For 24-hr operation, the values would be perhaps 10 per cent high.

Thomas compared the relative losses on the basis of the average losses for each type of bearing under loads ranging from 730 to 2,230 lb. per hanger. As the average load on hangers of this size is less than 730 lb., a comparison based on his 730-lb. value will be more useful under ordinary practice today. He made comparisons at two arbitrary bearing temperatures — 77 deg. and 100 deg. F. There is a great difference in normal operating temperatures of ball, roller, and babbitt bearings. Ball bearings do not warm up much, except at speeds far higher than those at which the other types can be operated.

In Table I is a comparison of the three types of bearings, with each at the normal operating temperatures for the loads and speeds assumed, such as 200 and 300 r.p.m., with loads of 230 and 730 lb. per bearing.

The 730-lb. load per hanger is about the average load to be expected for $2\frac{7}{16}$-in. shafting in a group where machines are crowded together and where all belts pull in one direction. A pressure of 230 lb. per hanger, with ordinary spacing, is a very light load.

The Dodge and Day tests, sponsored in 1909 by Henry Hess, were made on a $2\frac{7}{16}$-in. lineshaft, 72 ft. long, running about 200 r.p.m., driven by a 10-hp. motor and driving eight countershafts.

Tests were made on the same lineshaft running idle with all countershaft belts removed, both with ball bearings and with babbitt bearings. The average load per bearing due to weight of shaft and pulleys and to motor belt pull was 200 pounds.

To eliminate argument concerning the bearing pressures at no load and full load on the shafting, temporary countershafts were built. Each countershaft swung on a wooden frame hung from the ceiling. Definite, known tensions were put on the countershaft belts by means of a system of ropes, pulleys, and weights attached to the swinging frames. The losses measured include bearing friction, belt windage, and windage of the lineshaft pulleys.

In his analysis Hess made no allowance for pulley and belting windage. However, he published a diagram showing the sizes of all pulleys and belts used. Hence, it is possible to determine windage losses and deduct them.

TABLE I — FRICTION LOSSES UNDER NORMAL OPERATING TEMPERATURES OF BALL, SPIRAL ROLLER, AND BABBITT LINESHAFT-HANGER BEARINGS*

	Ball		Spiral Roller		Babbitt	
Load per hanger, lb.....	210	710	240	740	230	730
Watts per hanger, 200 r.p.m...	1.5	4	5	12.5	11	14.5
Watts per hanger, 300 r.p.m....	2.7	6.5	12	21.5	19	24
Average losses.....	2.7		12.9		17.1	
Relative losses referred to babbitt as 100 per cent.....	21.6		76.5		100	

*Based on Thomas's University of Wisconsin tests.

TABLE II — SUMMARY OF HESS DODGE-AND-DAY LINESHAFT FRICTION TEST RESULTS

Test No.	Total Load, 10 Lineshaft Bearings	Average Load on Idlers	Total Friction, Watts		Saving, Watts	Ball Bearings Instead of Babbitt (on lineshaft only) Per Cent Total Friction Saved	Per Cent Total Hp. of Drive Saved*	Conditions†
			Babbitt	Ball				
1	2,350	111.3	466	402	64	14	...	(a)
2	2,762	194	660	467	193	29	...	(a)
3	3,262	278	934	598	336	36	4.5	(b)
4	3,793	361	1,117	722	395	35	5.3	(b)
5	4,377	444.7	1,154	869	285	25	...	...
6	4,977	528	1,301	974	327	25	...	...
Average of load tests:			939	672	267	..	3.6	...
7	2,000	0	118	61	...	52	...	(c)
8	2,000	0	208	72	...	65	...	(c)

Total friction of load tests Nos. 1 to 6 inclusive, expressed as per cent of full load on drive, ball bearings 9 per cent, babbitt 12.5 per cent.
Total friction of load tests Nos. 3 and 4, expressed as per cent of full load on drive, babbitt 13.7 per cent.
*Hess does not state the average horsepower load on the drive. The motor ordinarily used on the drive was rated 10 hp. Figures in this column are only a rought estimate.
†(a)—Drive underloaded. (b)—Roughly full load. (c)—Main shaft running light; countershaft belts off.

Hess's results agree remarkably well with Thomas's results for ball bearings. For babbitt bearings the results fit in well with my tests. The Dodge and Day test results, which are summarized in Table II are rough but reliable. The figures obtained in this series of tests are plotted in as points on Figs. 4 and 5, for comparison with the other.

The crudity of the Dodge and Day tests resulted from ignorance of the following facts:

(*a*) Friction losses in babbitt bearings vary greatly with bearing temperature, decreasing roughly 50 per cent in the first four hours of running.

(*b*) Pulley and belting windage is not negligible.

Hess was surprised at the variation in the percentage saving in bearing friction shown in his six tests, which did not agree well with each other, nor with his rough, theoretical analysis. This was largely due to the factor (*a*) above. He felt sure that tests Nos. 1, 2, 5, and 6 did not do justice to ball bearings, and found plausible reasons for eliminating them. Judging from the results of other independent tests it is likely that a fairer comparison is obtained by averaging his first six tests.

An average lineshaft 72 ft. long on a 10-hp. drive serving eight machines will show, in practice, 12 to 20 per cent "friction" as determined by a test with machines shut down. A logical analysis shows that the friction under full load should be about the same. Hess's tests shows that it is. Assuming that the 10-hp. motor on this drive was reasonably well suited to its load, with normal belt tensions he obtained a friction of 14 per cent—an excellent check with the results of later investigators.

I have never tested a group drive having the very low losses that Thomas obtained for babbitt bearings. However, data taken on drives under average conditions check the ball-bearing data in Figs. 1 and 2 remarkably well. Ordinary conditions of installation do not seem to increase the friction losses in ball bearings. I have no corresponding data on roller bearings, but I believe that for well-maintained, spiral roller bearings this statement is also reasonably true.

Confirming this opinion are the results of some tests under practical shop conditions on group drives with spiral roller bearings. These tests are not directly comparable with the data under discussion, because they include the losses in pulley and belt windage, and certain miscellaneous losses. However, I find a fair agreement with the data in Fig. 1 after making the best rough allowance possible.

From the tests by Dodge and Day, on a $2\frac{7}{16}$-in. lineshaft and from other sources, a fair idea can be obtained of what may be expected of good, wick-oiled or ring-oiled hangers.

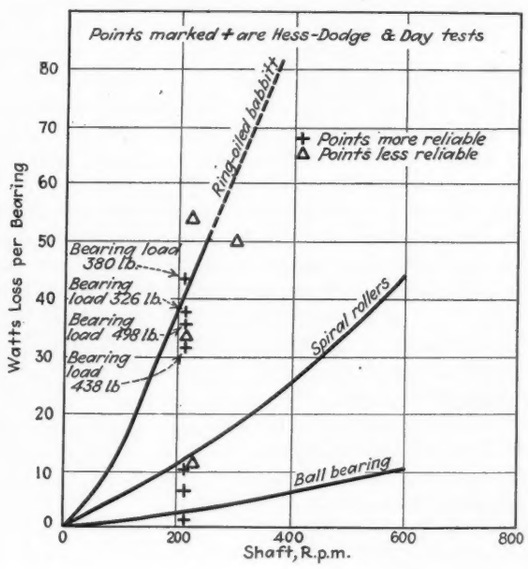


Fig. 4—Losses in $2\frac{7}{16}$-in. lineshaft hangers with ring-oiled, babbitt, and spiral-roller bearings are shown to the right. Bearing loads 400-500 lb., approximating practical shop conditions under average temperatures for nine-hour operation. These curves were obtained from tests made by the author. Results obtained in the Dodge and Day tests have been plotted in as points, for comparison.

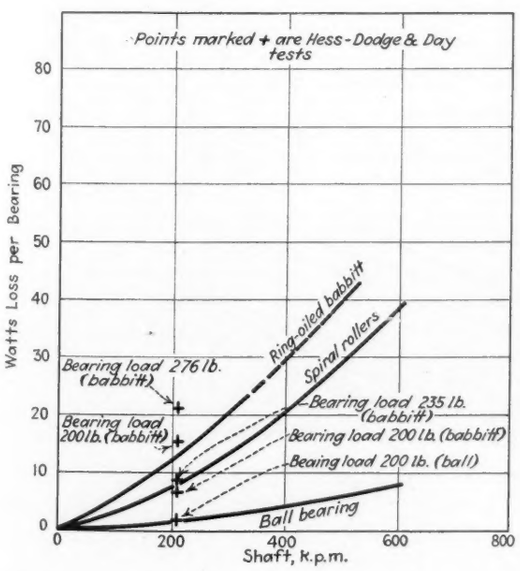


Fig. 5—At the left are shown friction losses in $2\frac{7}{16}$-in. lineshaft hangers with bearing loads of 200-250 lb., under practical shop conditions and average temperatures for nine-hour operation, from tests made by the author. Results obtained in the Dodge and Day tests have been plotted in as points, for comparison.

Pulley Windage

About twenty years ago the American Pulley Company, with the assistance of Professor Pryor, of Stevens Institute, made many tests on pulley windage, of which about 50 were published. These tests covered a variety of sizes of three different makes of steel pulleys. Later the results of tests made at Purdue University on two wood and one cast-iron pulley, of the same nominal size, were published.

The curves in Fig. 6 represent these data. They cannot be precise, for various reasons, but they make possible a very fair estimate of pulley windage.

The curve representing the windage losses of both sides of the belt per square foot of belt (area of one side) has been drawn for comparison. Evidently on narrow pulleys the fan effect of the spokes is large. On wide pulleys the air inside revolves to a great extent with the pulley, and spoke-fanning losses are proportionately much less. There is very little rim friction on the inside of the rim of a wide pulley; for there is little relative motion between air and rim. This explains why rim-friction and

TABLE III—WINDAGE LOSSES OF BELTING

Belt Velocity Ft. per Min.	Watts Loss per Sq.Ft. Surface, from Pipe Experiments	Watts Loss per Sq.Ft. Belt Surface, Deduced from Data Taken at 5,000 Ft. per Min.	Approximate Watt Loss per Sq.Ft. Belt
500	0.07	0.09	0.17
1,000	0.28	0.35	0.7
1,500	0.63	0.80	1.56
2,000	1.0	1.4	2.8
2,500	1.75	2.2	4.35
3,000	2.5	3.15	6.25
3,500	3.4	4.3	8.5
4,000	4.5	5.6	11.15
4,500	5.5	7.0	14.1
5,000	7.0	8.7	17.4
5,500	8.5	10.6	21.0
6,000	10.0	12.6	25.0

spoke-fanning losses on wide pulleys are less per square foot of rim surface, one side, than belt losses.

It is evidently worth while to cover the ends of high-speed pulleys with sheet metal, as is often done on punchpress flywheels. Such closure will eliminate spoke-fanning losses almost entirely, if the sheet metal fits closely inside the rim.

Belting Windage

There seem to be very little experimental data on belt windage alone. On the basis that it makes little difference whether the air or the belt moves, we may estimate belt windage losses from experiments on friction losses of air flowing in pipes with velocity high enough to produce turbulent flow. Belt windage losses are probably somewhat higher than the values deduced in this manner.

The second column in Table III is based on analysis of data on air flow in pipes, with due allowance for roughness. In computing the most economical speed for belting, windage losses have not been considered heretofore. The economic advantage of speeds over 4,000 ft. per min. is small, and the increase in windage losses rapid. Considering windage losses, the maximum economical speed would seem to be about 4,000 ft. per min.—not higher.

In my own work I used these values for lack of anything better. I used these data for several years in some studies of the economic possibilities of lineshaft speeds higher than those now used. Later three determinations of the combined bending and belt-windage losses on three heavy, single, or light, double belts—an oak-tanned belt, a mineral-tanned belt, and a vegetable-tanned belt faced with mineral-tanned leather — were made in a series of tests performed in France for an American manufacturer. These tests were made at belt speeds near 5,000 ft. per min. Results as reported included the losses in two pulleys, which can be roughly approximated and deducted. Combined bending and windage losses per square foot of belt, corrected to 5,000 ft. per min. speed, were: combination belt, 27.7 watts per sq.ft. (net belt surface); oak belt, 25 watts per sq.ft.; mineral-tanned belt, 26.3 watts per sq.ft. of belt.

The belts differ considerably in thickness, and stiffness; also, a mineral-tanned belt may be expected to be more flexible than an oak-tanned belt. As the stiffness undoubtedly varied greatly, and the sum of the bending losses and windage varied scarcely at all, I judge that windage comprised almost the whole of this loss, with the bending losses on the order of 10 to 20 per cent of the total, perhaps less. The results of these French tests are given in Table III, columns 3 and 4. The agreement with column 2 is unexpectedly good, considering that columns 3 and 4 include bending losses. The data in column 2, Table III, thus appears to be within 10 per cent of the truth.

Belt Slip and Creep

In general, the effects of belt slip and creep on well-planned drives have been over-emphasized. If F. W. Taylor's belt-design recommendations are followed at all closely, slip and creep combined will seldom average 1½ per cent on each drive. In a group with countershafts on every machine, the average over-all creep and slip from motor to machine will generally be under 5 per cent.

With the complete elimination of the motor belt, as contemplated in my studies, a combined average total of about 3 per cent slip and creep from motor to driven machine might be expected. Of course, some machines in the group will show more slip than the average.

This discussion on the losses in group drives will be concluded in the next article in the December issue of Maintenance Engineering.

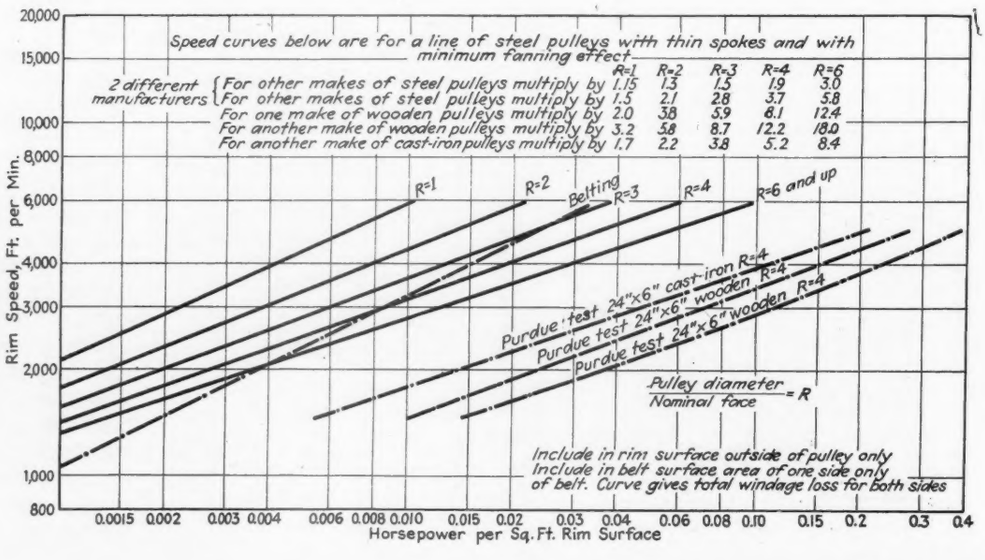

Speed curves below are for a line of steel pulleys with thin spokes and with minimum fanning effect
R=1 R=2 R=3 R=4 R=6
2 different manufacturers
For other makes of steel pulleys multiply by 1.15 1.3 1.5 1.9 3.0
For other makes of steel pulleys multiply by 1.5 2.1 2.8 3.7 5.8
For one make of wooden pulleys multiply by 2.0 3.8 5.9 8.1 12.4
For another make of wooden pulleys multiply by 3.2 5.8 8.7 12.2 18.0
For another make of cast-iron pulleys multiply by 1.7 2.2 3.8 5.2 8.4
Belting
R=1
R=2
R=3
R=4
R=6 and up
Purdue test 24"x6" cast-iron R=4
Purdue test 24"x6" wooden R=4
Purdue test 24"x6" wooden R=4
Pulley diameter / Nominal face = R
Include in rim surface outside of pulley only
Include in belt surface area of one side only of belt. Curve gives total windage loss for both sides
Rim Speed, Ft. per Min.
20,000
15,000
10,000
8,000
6,000
4,000
3,000
2,000
1,000
800
0.0015 0.002 0.003 0.004 0.006 0.008 0.010 0.015 0.02 0.03 0.04 0.06 0.08 0.10 0.15 0.2 0.3 0.4
Horsepower per Sq. Ft. Rim Surface

Fig. 6—Pulley-windage losses in horsepower per square foot of rim surface (outside surface of rim only). In using the windage curve for belting, shown for comparison, use area of one side of belt only; the curve will then give the windage for both sides.

PLANT ENGINEERS' FORUM

Here is the twenty-fifth of a series of questions, each of which has at least two sides. A new question will be presented each month, and our readers' answers to previous questions also will be published. Write down your opinions and send them to the editor. Answers published will be paid for at an attractive rate.

◆

Is There Profit in Spending?

George Shipman and Frank Fulleger have met at the market on Saturday afternoon, as they sometimes do when their wives are taken by the same notion at the same time—that notion being to economize on the food bills by doing the shopping in person. Of course their husbands have had to play chauffeur. Waiting being irksome, they talk. Frank begins.

* * *

"Boy, these are times—aren't they?"

"Right you are, Frank, but why the delayed outburst? We've had them for two years now."

"I suppose it's because I'm just getting my second wind, George. You know how it is in swimming and running. Half way to where you're going you think you'll never get there. But you get your second wind, you *do* get there, and you're surprised at how fresh you feel."

"That's good analysis. But what does it have to do with the depression?"

"A fair question, George. And here's the story: The old man had department heads on the carpet this morning. Believe it or not, he told us we'd have to economize. Didn't say economize *some more*—after all the scrimping we've been doing. First off I was mad—and I stayed that way. Got my dander up every time I thought of him sitting there calmly saying, 'We must economize.' I'm over it now, though, and I think I see things his way."

"Glory be, Frank. How come? And tell me about it."

"Well, he hinted that there might be possibilities for greater economy in my department than in the production department. I thought back over all the patching I've done in the last two years—never mind the details—and I figured I'd saved a lot of dollars by not spending them. Then I thought of the equipment that I figured we really ought to have but that I hadn't dared ask for. And that made me think that maybe I could make a new approach to the old man—show him how to economize by spending instead of saving money. I tied these thoughts up with the 'greater net profit, increased competitive ability' idea of yours, and the first thing I knew I sold myself the idea that the old man himself feels that way and that I can get some place with him along that line. So I guess I have my second wind."

"Not much for me to say, it seems, Frank. Apparently you have lined up with my principles. Now can you do it? And there come the ladies—let's help with those bundles."

* * *

Yes, that's the question. Can Frank do it? Have you maintenance and plant engineers who read Maintenance Engineering *done it?*

Are the principles outlined by Frank sound? Can money be made by spending money for equipment in times like these? What have been your experiences in increasing net profit, improving quality, cutting product unit cost in slack times by buying modern equipment?

(*Answers to previous questions start on the following page*)

READERS' ANSWERS

To Previous Questions

Interviewing Salesmen

(Question presented in the October issue)

I AM OF the opinion that it is highly desirable for the maintenance engineer to interview all salesmen that pay him the courtesy of a call. I say this despite the fact that in my own experience there have been innumerable occasions when such calls were highly inopportune from my viewpoint, when the product offered had no possible application to my needs, or when the salesman was ill equipped to give me the technical facts that I wanted about his product. Even such cases took very little time from my activities for I have found that, with the exercise of reasonable tact, I either could cut these interviews down to a few minutes or make an appointment for a later call. Frankness is the best policy when it is necessary or desirable to cut short an interview.

At times it has been a distinctly pleasant surprise to find that an interview, which at first seemed to hold no possibility of interest or applicability, revealed on closer examination a product or method hitherto unknown to me that proved decidedly useful. I also have found that, entirely apart from the product they are selling, salesmen often give me much information gleaned in their travels that can be applied profitably.

JOHN F. HARDECKER, *Chief Draftsman*
Naval Aircraft Factory
Philadelphia, Pa.

SALESMEN are a good deal like the advertisements in our business papers. Some of them are just friendly reminders that a good old product is still being manufactured and sold, while others carry a live, up-to-date message that is of great interest to some of us and a guide for our future plans.

At present most of us are pretty busy trying to unsnarl this depression and, consequently, dislike giving a lot of time to every caller who feels that he has a needed product. But, in fairness to the good salesmen, we also hesitate to deny any salesman a chance to tell his story, for his may be just the message that we have been waiting to hear. Often a salesman so paves the way for his visit by a series of letters or advertisements that he is received with interest.

At our plant the purchasing agent acts as a buffer in sorting out the specific type of salesman to interview each of our busy executives. Only when they have an appointment or a message of special interest to a certain executive do salesmen get into our plant.

Salesmen are valuable to all of us for, because they travel a great deal and visit many plants, they gather a lot of general engineering and business knowledge that is at our disposal.

CHARLES H. WILLEY, *Superintendent of Manufacture*
Hoyt Electrical Instrument Works
Penacook, N. H.

THE QUESTION of interviewing salesmen is especially timely just now when competition is keener than ever. Maintenance engineers and salesmen both must be more alert and up-to-date than in the past because fluctuations in operating and maintenance costs are reflected quicker in the balance sheet than under former conditions.

The salesman and engineer should meet frequently enough to become acquainted. Each should know the type of man with whom he is dealing, and the better the two are acquainted the easier it is for them to work together. Friendship and acquaintanceship should not be confused; the former should not enter into business relations. A salesman should call only when he has something definite in mind. If the object of his visit has to do with an engineering problem or development pertaining to the maintenance department, he should see its engineer. But, when the subject is such as can be handled by the purchasing department, the engineer should not be consulted. The engineer is quite as likely to have some specific problem as the salesman and, in such a case, he should call in the salesman. In either case the telephone is a mutual time and effort saver. A sufficient outline of the object in mind or problem at hand can be given over the telephone to determine whether or not the time given to an interview would be spent profitably.

The days of the regular friendly call of the salesman are past. Both classes, engineers and salesmen, now realize that such calls are a waste of time and effort and have had to modernize their methods accordingly.

JOHN P. SIMONS, *Plant Engineer*
Industrial Rayon Corporation
Cleveland, Ohio

EVERY salesman deserves business courtesy to the extent of an interview. When the maintenance engineer is interested in a salesman's product, he should see him in his office. But if he is doubtful or wishes to make the interview short, he can talk to him in the plant lobby. When the engineer is tied up or does not wish to see a salesman, the least he can do is to talk to the salesman on the telephone. In any case a salesman should not be kept waiting unnecessarily; his time usually is at least as valuable as the engineer's for he is under a heavy expense. A definite appointment should call for a punctual interview. In case the engineer's time is limited, the salesman should be informed of the fact immediately. It is an easy matter to end an interview with most salesmen without being discourteous.

When interested in the salesman's product, the engineer should listen to his entire story. In so doing he will find that the salesman not only knows his own product but also is familiar with the products of his competitors, and he knows the general trend of improvements in his line. Many salesmen are highly

trained specialists who can furnish the engineer in a few minutes data and information that would take several hours to gain in any other way.

HARRY SPILLMAN
Manager Power, Maintenance and Construction Division, Continental Motors, Muskegon, Mich.

IT WOULD be a waste of the salesmen's time as well as my own to interview each and every one that calls on me. When a salesman calling at the office is a stranger, my secretary asks him for his name, the name of his firm, and the product that he is selling. After this information is given to me, I usually can tell whether or not to grant him an interview. If there is any doubt, I always see the representative. If I do not grant an interview, the salesman is told the reason such as, that the product has no place in our needs or that we are under contract. If the latter situation exists, the salesman is told when he may call again. By using this method, we are able to weed out the nonessential from the essential and can devote more time to a salesman whose interests and ours are mutual.

A sufficient amount of time is given to each salesman to present his story. We have received a great deal of valuable information from salesmen concerning mechanical equipment, materials, and methods that have improved our processes and reduced costs. If you will meet the salesman half way, he will prove a valuable and willing aid in the management of the maintenance department.

L. H. DICKELMAN, *Building Superintendent*
Ed. Schuster & Company, Inc.
Milwaukee, Wis.

Should the Maintenance Department Have a Separate Inspection Division?

(Question presented in the September issue)

IT IS my opinion that there should not be a separate inspection division of the maintenance department. In most cases I am not in favor of one man doing the inspection work and another man coming along behind him to perform the repair work. Certainly a man who is capable of carrying out the repair work properly on certain equipment is in a better position to do a good job inspecting it than a man who does nothing but inspect a wide variety of equipment. Men capable of making a thorough inspection of all types of equipment are hard to find.

The method that I have used successfully in my inspection and repair work has been to hold one man responsible for the safe and continuous operation of each piece of equipment. In organizing my maintenance and inspection work I allocated the duties as far as was practicable without showing partiality or limiting the workman's experience to one line. Each man was made to feel that he had a department of his own to operate, with the result that he took considerable pride in his work as a combined inspector and repair man.

To assist the workman in getting started properly with his work he was given blueprints and the manufacturers' operating and maintenance instructions of the equipment under his jurisdiction. He also was furnished with typewritten instructions pointing out the required frequency of inspection, lubrication, and adjustments of the equipment under his care.

With such a method of combining inspection and repair in operation, expensive clerical and filing systems can be eliminated or materially reduced, inspection and repair often can be performed simultaneously, avoiding doubling back on the job, and the blame for equipment failures can be placed more accurately. Another important point in favor of this system of maintenance and inspection is that it affords an excellent means of training and developing key men for future foremen because of the diversified experience obtained in such work.

MARIN PHILLIPS, *Electrical Superintendent*
International Paper Company
Niagara Falls, N. Y.

THE organization chart of a modern plant shows that we are leaving behind us the divisional organization scheme of the good old days and are forging ahead with strenuous efforts to reach the ideal and most economical plant set-up which, without doubt, will be found in the proper application of the functional type of organization.

To explain briefly what is meant by a divisional and functional organization it may be stated that a divisional organization gives one man, or a group of men, one job to be done from A to Z, whereas a functional organization makes one man, or a whole crew, responsible for a definite function of all jobs that go through the plant.

I cannot but emphatically recommend that the maintenance department have a seperate inspection division. The maintenance department itself also should be functionalized, and an organization chart should be drawn to show clearly the functions to be performed by each division of the department. It is as logical to have a separate inspection division in the maintenance department as it is in the production department.

Results of a separate inspection division in the production department have proved its usefulness. Why not apply the same principles and methods to the maintenance department to obtain similar results?

F. J. WOLF, *Mechanical Engineer*
Homestead, Pa.

INSPECTION of plant equipment undoubtedly is a function of the maintenance department. Although it may not appear necessary to have a separate inspection division in the average plant, there should be at least one inspector working directly under the maintenance engineer. If the inspector's duties should increase so that he must have more and more assistance, the result probably would be that he will develop a division of his own. However, I do not advocate that inspection should be an officially recognized division; it should be a branch of the maintenance engineer's department. Each inspector should be responsible for the inspection of all equipment under his jurisdiction and should file regular reports with the maintenance engineer.

It is hardly possible that any one or two men in a plant can be conversant enough with all equipment to inspect it intelligently. For this reason many plants of

average size delegate the responsibility for inspection of the boiler room and its equipment to the power-plant engineer and the electrical equipment to the chief electrician. Obviously, it is not practicable in the average-size plant to put all these inspectors in one division. It does not, therefore, appear that a separate division is justified in relatively small plants. M. C. COCKSHOTT
J. B. Gill Corporation, Ltd.
Long Beach, Calif.

TO GIVE a definite answer to this question consideration must be given to the size of the organization and to conditions within it. However, in general, the maintenance department should have within itself a separate division to which is delegated complete responsibility for the inspection of equipment and for the upkeep of adequate records.

Inspection is an important function of maintenance. It will prevent breakdowns. It also will preclude delays, decrease accidents, and lower the cost of production. Furthermore, inspection is a source of information regarding the efficiency and suitability of certain equipment and processes. Such objectives are important enough to warrant a separate organization.

In order to derive the maximum benefit from inspection of equipment and to obtain complete executive control over it, it is both advisable and feasible to organize a separate division of the maintenance department in charge of, and responsible for, inspection.
GEORGE E. BAGBY, *Engineering Division*
Procter and Gamble Company
Cincinnati, Ohio

IN MY opinion it would be good practice to set up an inspection department that would be not only separate from the rest of the maintenance department but entirely isolated from both the maintenance and operating departments. The new department would report to the same man as the other departments.

I have known cases where inspections were made by a division of the maintenance department in which the tendency was for the maintenance engineer to "pass the buck" to the inspection division when anything went wrong, even though the defect previously had been reported by the inspection division.

This trait exists in a great many human beings who otherwise are perfectly honest.

Another good reason for an inspection department separate from any other department is found in the fact that inspectors must have a type of education or aptitude possessed by few men; that is, their powers of observation and analysis must be highly developed. I do not believe it necessary for them to be either good repair men or operators, but they must be able to observe the most minute details, to analyze conditions, and to estimate the safe useful life of plant equipment.

With the inspection department separate from the operating and maintenance departments there is no tendency for inspectors to favor either of the other departments when allocating expense or recommending a change in operation or maintenance for the benefit of the apparatus involved. In other words, inspection could report operation abuses and maintenance laxity without fear or favor.
H. R. WILLIAMS, *Chief Engineer*
Ash Grove Lime & Portland Cement Company
Chanute, Kan.

What Qualifications for a Maintenance Engineer?

(Question presented in the August issue)

A MAINTENANCE engineer should be experienced along mechanical, electrical, and construction lines. Although a knowledge of civil engineering would be an asset, it should not be classed as a necessary requirement. The experience should be practical, gained from actual work as an apprentice or as a student under instruction in the above fields. The amount of experience necessary depends entirely on the person.

A technical education plus practical experience is a combination hard to beat. A man who has not had the benefits of a technical education soon realizes that he must have its equivalent to compete with men with such training. The result is that he uses the home-study method to train himself. Such study should pertain not only to his own field but also should give him a working knowledge of cost systems and production methods.

The maintenance engineer's personality should be of such a nature that his employers and the men in his department will have confidence in him. The various department heads should be made to feel that he is ready at all times to assist with their problems.
W. R. SIMPSON, *Plant Engineer*
Thermoid Rubber Company
Trenton, N. J.

A PLANT maintenance engineer has such an enormous responsibility in the proper discharge of his duties that he should rank with the highest officials in industry. Such responsibility calls for qualifications that are unique in that they embrace a knowledge of diplomacy and technical plant operation as well as a rare type of executive ability.

A man who wants to tackle this man-sized job must have a fatherly love for machinery. He must know plant equipment and all its fundamentals. A man who has not had practical experience in the machine shop cannot solve mechanical problems nearly as well as one who has worked with his hands.

Executive experience is another requisite that cannot be overlooked in studying a man's qualifications. A man who cannot handle men should not be expected to cope with problems of the type that come up in maintenance engineering.

Diplomacy goes a long way in almost any line, but it is certainly essential as a qualification of the maintenance engineer. He must come into contact with men in the shops and in the executive offices. He must handle delicate situations with tact to avoid friction between the various departments. Tact and a suitable personality travel hand in hand.

A college man has the edge on the man who has worked up from the ranks because he has studied systems and methods. The latter man has little time to acquire this knowledge by study and must gain it from practical experience. In this respect only has the man with a technical education an advantage over the man who has come up from the shop.
PHILIP DEL VECCHIO
Sipp Eastwood Corporation
Paterson, N. J.

Signaling System Dependable?

Periodic maintenance is the only guarantee that your fire-alarm and police signal systems are on the job.

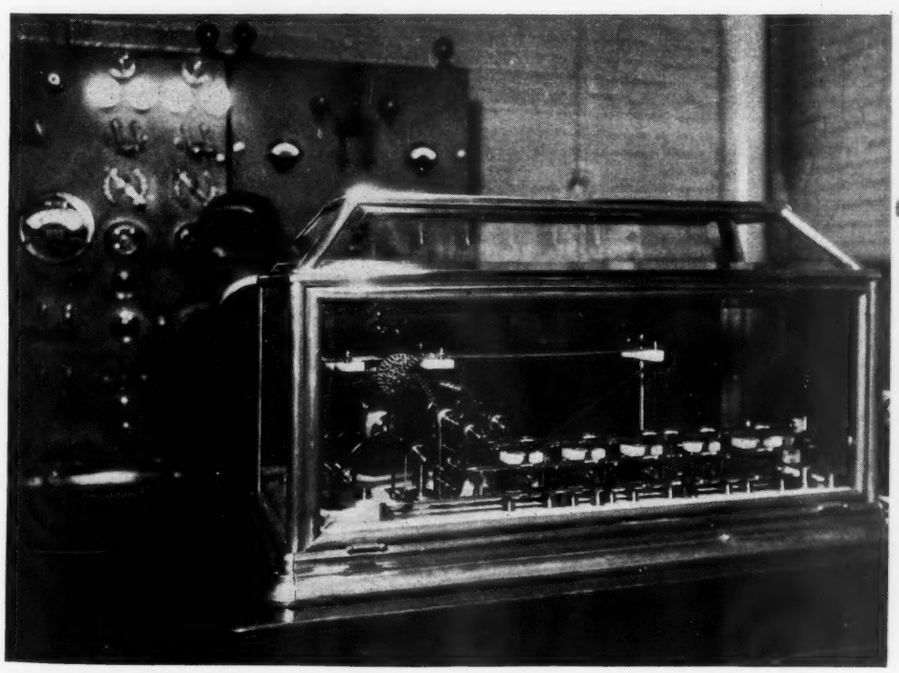
W. WENDELKIN
Supervisor of Lighting
Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

MOST industrial plants and buildings are equipped with fire alarm systems and police recording systems in order to conform to insurance and other regulations. These systems are usually electrical in nature and it is necessary that attention be given to the proper maintenance to insure their functioning at all times.

The purpose of a fire alarm system is to give a definite indication at some central point in the plant that a fire has occurred in some other part of the plant. Transmission of the alarm is usually accomplished by manual operation of auxiliary signal or pull boxes located at various points throughout the plant which, when operated, give a visual or audible indication at the central recording point, thus notifying the management or the plant fire-fighting organization that a fire hazard is present at the point in the plant indicated by the location of the box or signaling device that has been operated.

Although there are many different types of fire alarm systems, they are practically all electrical in nature and are usually of the closed-circuit, non-interfering type; that is, the energizing circuit from the central point is connected in series with the various boxes on this circuit, and is constantly energized. The circuit usually is

Fire-alarm boxes such as this must work all the time. Repairs can't be made after a fire has started.



Control room for the fire-alarm system. The repeater is shown in the foreground.

Recording desk at police headquarters. The tape contains a visual and permanent record of the boxes pulled by the policemen on their rounds through the plant.

Fig. 1—A daily report on the condition of the fire alarm system is made out on this form.

FIRE ALARM SYSTEM REPORT

Report No..... Date.....

Box No.	Location	Remarks	Gong No.	Location	Remarks

FIRE ALARM BATTERIES

BATTERY NO.	TIME OF CHARGE		BATTERY WORKING		REMARKS	CIRCUITS		
	ON	OFF	ON	OFF		NO.	AMP.	VOLT

CIRCUITS NO.	GONG BATTERIES REMARKS	CIRCUITS NO.	AMP.	VOLT

SWITCHBOARD

DESCRIPTION	REMARKS
Repeater	
Register P. H.	
Register F. D.	
Whistle Blowing Machine	
Time Relay	

GENERAL REMARKS

Signed..... Inspector

arranged so that only one box may be operated at a time. After one box has started to send in its signal no other box on the same circuit can interfere until the first box has completed its signal. If reasonable attention is given to its maintenance such a system provides a very reliable means of reporting fires.

Electrical recording systems for police likewise are of many kinds, but probably the most practical system for large or medium-sized plants or buildings is one that includes various pull boxes located throughout the works. When the boxes are operated by the policeman making his rounds, a visual and permanent record is made on a tape feeding through what is known as a register, which is located at headquarters. In the better class of systems, provision is made also for telephone communication between these outlying boxes and headquarters.

In contrast to the usual fire alarm systems, the stations of a police recording system of the type mentioned above are connected in parallel instead of in series.

How maintenance work is carried out in a plant where a total of 175 fire alarm pull boxes and 150 police recording boxes are installed will be described in the following paragraphs. Although the methods outlined may not be applicable entirely to all installations, the general procedure and principles may be of some help to those who have similar installations in service.

In connection with the maintenance and inspection of the fire alarm system, the following schedule shows how often checks are made and what is done at the periods indicated:

Daily

(*a*) Check batteries for proper voltage and current three times a day. (Two batteries are used on this system — one battery being for stand-by service; batteries are charged and used alternately).

(*b*) Check all charging equipment, m.g. sets, rectifiers, and so on.

(*c*) Check all circuits for grounds.

Weekly

(*a*) Pull in one box on the system for a complete round of signals. The box to be operated is designated by the fire marshal of the plant. This test checks all gongs, relays, whistle-blowing machines, and other parts of the system.

(*b*) Rewind all gongs, bells, and spring-operated devices.

Monthly

(*a*) Check all pull boxes with low-resistance telephone receivers connected across box terminals, and check for proper operation of star wheel in box.

(*b*) Make general inspection of complete system, including auxiliary equipment and wiring.

In connection with the daily check-

ing it will be noted that two batteries are used on this system, one battery being held for stand-by service; the batteries are used and charged on alternate days. It is recommended that this practice be followed for reliable and consistent operation of the system. If dependence is placed on one battery alone, failure of this battery will, of course, result in a complete failure of the system itself.

It is also recommended that one properly trained electrical maintenance man be placed in charge of the entire system, whose duty should be to see that the system is in perfect operating condition at all times.

In Fig. 1 is shown a daily report sheet that is made out by the man in charge of the system, and turned in daily to the management or plant engineer. It will be noted that this report sheet has space provided for reporting the daily condition of all boxes, batteries, gongs, and other auxiliary equipment used.

A typical test terminal block which has been developed for testing purposes, and which can be located at various points throughout the wiring of the fire alarm system, is shown in Fig. 2. This test block is so arranged that various circuits can be cut in or out for repair or testing without interrupting or opening any part of the series loop.

Shown in Fig. 3 is a device that has been developed for indicating low voltage on either of the fire alarm batteries. Connected across the batteries are voltage relays with voltage coils designed to release at approximately 10 per cent under voltage, thus to close the relay contacts, ring the signal bell, and light the indicating lamp on the battery that has dropped in voltage.

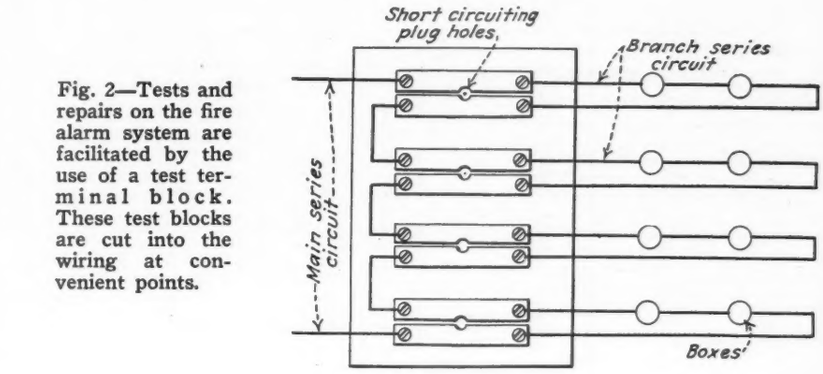


Fig. 2—Tests and repairs on the fire alarm system are facilitated by the use of a test terminal block. These test blocks are cut into the wiring at convenient points.

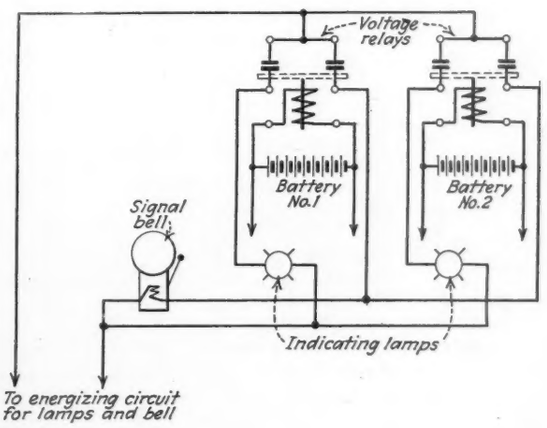


Fig. 3—When the voltage on the fire alarm system battery drops about 10 per cent below normal the voltage relay contacts close, the bell rings, and a lamp indicates the low battery.

One of the police pull boxes in the plant. This station is also equipped with a telephone.

The maintenance of the police recording system follows very closely that of the fire alarm system, with the possible exception that the requirements are not quite so strict as those needed for the fire alarm system.

An inspection routine recommended for police recording system maintenance is:

Daily

(*a*) Charge batteries and inspect power equipment, m.g. sets, rectifiers, and so on. Two batteries are in service on this system, as in the case of the fire alarm system; they are charged and operated alternately.

(*b*) Check all circuits for grounds.

Semi-annually

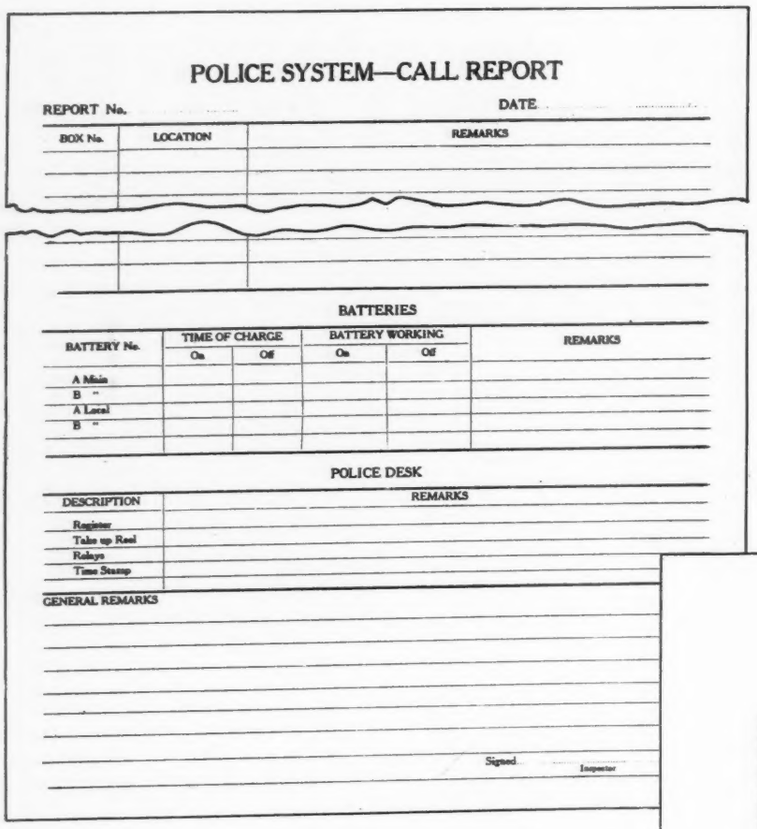
(*a*) Check all boxes for star wheel adjustment and proper operation.

(*b*) Make general inspection of complete system, including wiring, recording registers, time stamps, and so forth.

In Fig. 4 is shown a watchman's recording or police system call report, which is made out daily by the maintenance man and turned in to the management.

The report sheet on the police recording system, Fig. 5, is made out daily at the police headquarters by the head watchman or captain of police and then turned in to the management.

This arrangement gives a double check on the system—from both the maintenance and police departments.



POLICE SYSTEM—CALL REPORT

REPORT No. ..... DATE .....

BOX No.	LOCATION	REMARKS

BATTERIES

BATTERY No.	TIME OF CHARGE		BATTERY WORKING		REMARKS
	On	Off	On	Off	
A Main					
B "					
A Local					
B "					

POLICE DESK

DESCRIPTION	REMARKS
Register	
Take up Reel	
Relays	
Time Stamp	

GENERAL REMARKS

Signed ..... Inspector

In the plant in which the maintenance routine outlined above is in force the man in charge of the fire alarm and police systems is an electrician reporting to the wiring department; the head of the wiring department, in turn, reports to the superintendent of buildings. As the work is mainly electrical, it was found desirable to choose a first-class electrical man for it. Where large systems are installed, it is recommended that the man responsible for their maintenance have a helper or understudy who can be trained properly in the work; then in the event of trouble, which may occur at all hours, two trained men will be available.

In the set-up outlined above, the maintenance man's duties are those of sole responsibility for the operation of the system. Responsibility for the operation of fire-fighting equipment—hose, reels, extinguishers, fire trucks and other equipment—is delegated to a fire marshal, who likewise reports to the superintendent of buildings. The fire marshal's duties, in addition to his jurisdiction over fire-fighting equipment, also include the rendering of reports on fires. He has charge of all insurance adjustments arising from loss by fire and settles all disputes regarding any fire hazards that may be present throughout the plant.

It is hoped that the methods outlined above may be of help to those who have fire alarm or police recording systems installed in their plants, although it is to be understood that no one set of instructions can cover all of the different types of equipment that are being manufactured and sold. Nor is this article intended to be a recommendation for any particular type of system; its purpose is merely to outline, in a general way, good procedure for the maintenance of continuous and dependable service from signaling and alarm systems of this nature.

Fig. 4—The condition of the police recording system is reported to the management daily, on this form, by the maintenance man.

Police Signalling System.

Daily Switchboard Log

Batteries on Line

Batteries		Time On	Time Off	Volts Start	Volts. Finish
Main Line 24 cells	A	A			
	B				
Local 12 cells	A				
	B				

SWITCHBOARD OPERATION

REMARKS:- - - -

BOOKS

Practical Mathematics for Home Study

By Claude Irwin Palmer, late Professor of Mathematics and Dean of Students, Armour Institute of Technology, Chicago, Ill. McGraw-Hill Book Company, Inc., 330 West 42nd St., New York, N. Y. Second edition, flexible binding, 606 pages. $5.

"PRACTICAL Mathematics for Home Study" is the outgrowth of Dean Palmer's 29 years' association with evening students at the Armour Institute of Technology.

The types of problems covered are those most generally encountered by practical men in their every-day work. The book is divided into four parts—Arithmetic, Geometry, Algebra, and Trigonometry. A summary of formulas together with tables of equivalent units, mechanical standards, logarithms, and trigonometric functions is appended.

The part on arithmetic gives such preliminary work as operations upon fractions, a discussion of weights and measures, the theory of ratios and proportion, and a brief treatment of powers and roots.

The section on geometry lays special stress upon computation of areas, the solution of triangles and circles, and upon graphical methods and constructions. Solutions of cylinders, pyramids, and other common solid shapes are also given, although solid geometry, as a distinct field, is left untouched. One finds no formal—or formidable—presentation of "propositions" accompanied by their classical pragmatic proofs. There is a wealth of illustrations, and a great number of practical problems and examples taken from varied fields of endeavor. The mechanic and contractor will find much here of interest and profit.

Although more abstract fields are touched in the part devoted to algebra, there is much of immediate value, especially in the chapter on graphical methods and functions, and in the one on logarithms. The author has limited his scope to quadratic equations. While algebra does not lend itself to as many "shop" applications as geometry, many practical examples are given, problems dealing with electricity, strength of materials, and horse-power calculations. The short chapter entitled "Variations" is extremely worth-while, for it explains how certain physical relationships naturally lend themselves to mathematical expression and treatment.

Part Four, on trigonometry, ties up what the student has learned about geometry and algebra. Functions of angles are explained. The examples in the first part of this chapter are of interest mainly to the surveyor, although the mechanic and designer also will find pertinent material. The latter part of the chapter, on "graphical representation," touches periodic functions, albeit very sketchily. It is to be regretted that the author did not consider alternating phenomena worth mentioning, since the discussion of the projection of points having uniform circular motion seems to prepare the ground so ably. However, in encompassing so varied a subject between the covers of a single volume, the author must often have been faced with perplexing questions of omisison and inclusion.

The book will be a valuable addition to any man's library who wishes to pursue his education "on his own"; and should not be overlooked by many a graduate engineer who, since leaving school, has allowed his mathematical tools to become a trifle rusty.

■

Principles of Electrical Engineering

By George C. Blalock, Associate Professor of Electrical Engineering, Purdue University, Lafayette, Ind. McGraw-Hill Book Company, 330 W. 42nd St., New York, N. Y. First edition, cloth binding, 498 pages. $4.

THIS book seems complete in its subject range, and rather better illustrated than the average electrical engineering textbook. The back of the book is devoted to 35 laboratory experiments. The principle followed in the writing was to prepare a work of reference for non-electrical students who were taking electrical engineering courses for a grasp of the fundamentals, rather than for men making that subject their major field of endeavor. As a result, involved mathematical proofs have been avoided, as have any instructions in electrical design. This fact makes the book valuable to the non-college man.

■

Structural Steel Welding Committee Report

Published by the American Welding Society, 33 West 39th St., New York, N. Y. Paper, 6x9 in. 208 pages, illustrated. $1.

IN THIS volume are recorded the results of a five-year program of investigation undertaken by the structural steel welding committee of the American Bureau of Welding. The committee was organized in 1926 for the purpose of "obtaining reliable information upon which to base safe unit working stresses in the designing of welded structures."

The principal objects of the investigation were to determine:

1. Safe design values under static loading for various types of fusion-welded joints as commercially welded in structural steel fabricating shops.

2. The degree of uniformity of the strength of welded joints that may be expected from such shops throughout the country.

The investigation included the welding and testing of 1,098 specimens in connection with the qualification of the welders, and 1,395 specimens in the investigation proper. The latter involved study of 55 elemental forms of joint in 169 sizes. The participants included 3 steel mills, 39 fabricating shops, 61 welders, 18 inspectors, and 24 testing laboratories.

The results of the tests are clearly detailed and well illustrated. Cross-reference to the subject matter, which is divided into ten sections, is facilitated by the Dewey decimal index system.

This report should be very valuable to all who are concerned with the application of welding to structural work.

■

National Electrical Code

1931 edition. Printed by the National Fire Protection Association, 85 John St., New York, N. Y. 5 cents.

THIS edition represents the 15th revision of the original National Electrical Code, first published in 1897, sponsored by the National Fire Protection Association.

In addition to many editorial changes in the text some new material has been added and important revisions have been made in certain articles and sections. For example:

Changes in Article 4, allow, under special permission, buildings having multiple occupancy to have more than one set of service conductors, and approve the use of new forms of multiple-conductor service cables. The utility meter is permitted to be placed ahead of the service switch and service fuse under certain conditions and branch circuit breakers may be used, with safeguards, instead of main service switches.

Changes in Section 508, Electrical Metallic Tubing, give a broader recognition of this new raceway. Two new sections cover Wireways and Busways, and Auxiliary Gutters.

In Article 6, Conductors, changes in nomenclature and classification have been made.

Many changes were made in Article

(Please turn to page 564)

MAINTENANCE ENGINEERING

L. C. MORROW, Editor

NOVEMBER, 1931

Welcome to Our New Home

THIS issue marks another important event in the history of *Maintenance Engineering*, for it is the first one to be printed in the new building that has been erected by the McGraw-Hill Publishing Company, Inc., at 330 West 42nd St., New York, N. Y. Our editorial offices have been moved from Chicago and henceforth will be located in the splendid structure that houses all departments of the McGraw-Hill publications. All communications should be sent to the new address.

The editors extend to all the readers and friends of *Maintenance Engineering* a hearty invitation to visit them in their new home. It will be a pleasure to conduct visitors through the plant and to show them that the facilities for producing our publications are complete. A feature of the new building is an auditorium, in the use of which the McGraw-Hill Company stands ready to cooperate with associations and societies.

Unemployment Panaceas

THE DEPRESSION has spawned an inordinate number of economic medicine men, each with his favorite nostrum to cure our unemployment evils. Everything from Communism to *laissez-faire* has been advocated.

Many cures tried in other countries have had none too happy results. The fund for the dole in England, "in the red" since March, 1928, now represents a debt to the government of approximately 400 million dollars, and is admittedly open to abuse. In Germany a similar fund, created in 1927, was already being sustained by governmental loans in 1929, and by 1930 had swallowed up almost 130 million dollars of public money.

In America not the end, but the means, are in dispute, for it seems universally agreed that some concerted action—public or private—should be undertaken. Figures recently published by the U. S. Bureau of Labor Statistics show that there are only 79 unemployment-benefit or employment-guaranty plans in operation in the country. Of these only 15 are company plans. The number of workers affected by all 79 does not exceed 226,000—a small percentage of our 50,000,000 workers.

A new light was shed upon the whole question recently by James W. Hook, president of the Geometric Tool Company, in an address before the Conference on Management Problems of the Smaller Industries. Mr. Hook pointed out that our major responsibility lies in caring for what he termed "stable workers." He estimated that only about 40 per cent of our 5,000,000 unemployed come under that category.

Mr. Hook therefore suggests for consideration the setting up of a definite program whereby industry as a whole will undertake to determine the stable employees in each industrial unit. The cost should then be calculated, in per cent of the unit payrolls, of spreading over the decade or so of "good times" which seems to precede each major depression, the burden of protecting these workers when but little work is to be had. The mechanics of his scheme, which is one of private control, include the setting up and administering of definite unemployment reserves, under governmental regulation. The machinery for administering a reserve accounting law he points out as already existing in the Divison of Audit of the Internal Revenue Department.

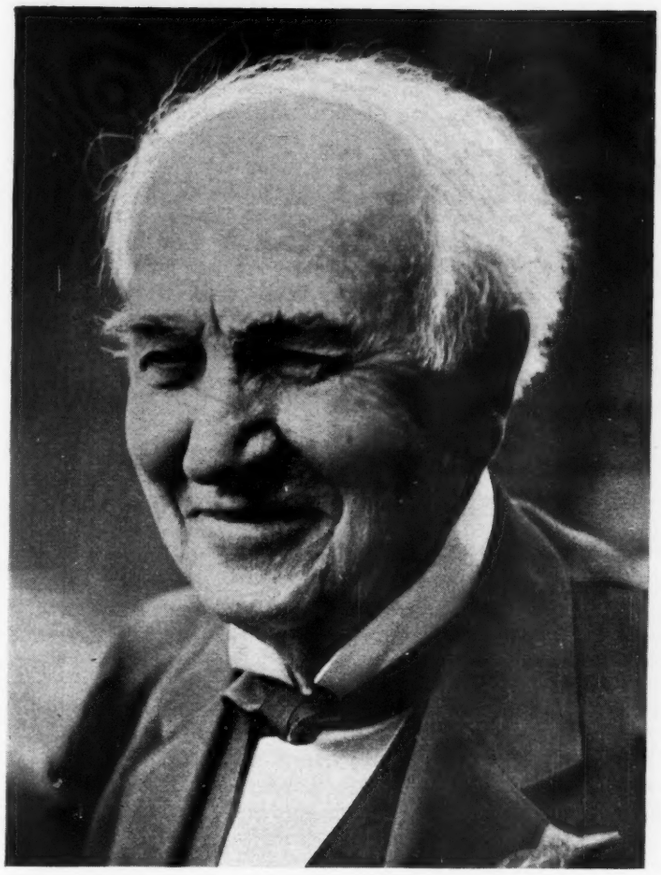
The results of a survey made in his own company, which showed that the surprisingly small reserve of only $\frac{3}{4}$ of 1 per cent of his payroll for the years 1923-29 inclusive would have been needed for adequate protection, may be found in his address as reported in the October issue of *Mechanical Engineering*.

Sound Engineering and Sound Banking

FOR MANY months we have been advocating plant modernization as a logical move while sales and production are sluggish. Now we find that our proposed remedy and cure for "hard times" have won a second from a member of the profession of business doctors—i.e., from a banker.

In a recent issue of *Nation's Business* Charles S. Paull discusses the "business angle" of banking. He points out, among other things, that banks would profit by making a more determined effort to "sell" their product, credit, to those sound organizations whose management has been made over-chary of expansion by the present flurry of economic deflation.

Before Mr. Paull turned banker he was a well-known business man. His experiences in both fields have led him to remark, "As a credit manager in my own business, I feel that our bank should be *selling* credit for plant remodeling and expansion."



Thomas Alva Edison

February 11, 1847 October 18, 1931

BORN into the simple austerity of a pioneer home, without the trappings and circumstance of wealth or high position, Thomas Alva Edison created for himself a position that is unique in the annals of science and invention. Modest, forgetful of self, relentlessly driving body and mind to efforts that were cruelly fatiguing, he labored in the happy peace and quiet of his laboratory unmindful of the fame and adulation which an admiring world forced on him.

His name is spoken with reverence by those who are great in every field of human endeavor—it is equally well known in the humble households of those who perform the physical tasks imposed by civilization.

Insatiable curiosity, an adventurous spirit that found its expression in endless experimentation, an amazing clarity and resourcefulness of mind—these and many other high qualities were combined in rare degree to produce the genius that was Edison's. The times in which this genius unfolded were peculiarly propitious for its full fruition. Considerable of the groundwork on which the great sciences of chemistry and electrical engineering rest had been roughly hewn out by Davy, Faraday, Maxwell, and other outstanding pioneers who had labored valiantly to make a clearing in the dark forest of the ignorance and superstition that enshrouded natural phenomena. Fundamental equations and helpful, if not entirely accurate, concepts had been evolved to explain some of the workings of Nature's forces. Such knowledge was, however, the possession of only a comparatively small group of learned men of science. In its practical application small progress had been made. Edison's self-appointed task was to gather up these bits of scientific knowledge and through the medium of the rarest kind of inventive genius fashion them into practical devices that in such amazing fashion have lighted the dark places, helped to lift heavy burdens from the backs of those who labor, and blessed the peoples of all lands.

There were no boundaries to the range of his interests: few branches of applied science or engineering are there to which Edison did not make notable contributions. Limitless also were the energy and resourcefulness which he brought to bear on every problem that engrossed him. If knowledge was lacking to perfect some machine or process, he delved tirelessly in library and laboratory until the missing facts were found. If the development of auxiliary devices was essential to the success of some project, he accepted that burden without question or complaint and labored with fabulous concentration until every element of his creation was practical and complete.

Probably no man of modern times has had the privilege of influencing so profoundly the lives and fortunes of his fellow men. Any one of a score of his inventions would have given him undying fame. Taken together they constitute a monument and a record of accomplishment such as no man has ever had before. Devoted to the arts of peace, Edison's labors have made life vastly richer and fuller for countless millions.

Simple, kindly, with the vision of a prophet of old, Edison possessed in abundance those elemental, rugged qualities of heart and mind that the world must, perforce, always admire.

An illustrious name and a life of unparalleled accomplishment have passed into the mellow realm of History. In the death of Edison the world has lost a renowned and worthy citizen, and mankind one of its greatest benefactors.

THIS OILING SCHEDULE PAYS DIVIDENDS

A. A. A. RODRIQUES
Maintenance Electrician, Candy Headquarters
New York, N. Y.

MANY plant executives are satisfied to know that their motors or other mechanical devices are operating satisfactorily as far as the eye can see. Consequently, in many instances, it matters naught to them whether a motor operates at maximum efficiency as long as it performs a given amount of work in a given time. Frequently, a motor is installed with a new machine. Both are oiled to overflowing and work begun. No more thought is given to the motor but, as the machine generally is serviced by an attendant, it gets a little attention once in a while. The backbone of the machine, however, the motor, usually is forgotten until a peculiar smell of burning insulation or hot bearings call attention to its existence.

Oiling Schedule

An oiling system which the writer devised, when given charge of the maintenance of several hundred motors ranging from fractional to 35 hp. in capacity, has proved highly efficient and, although it required nearly three months of constant plodding for its completion, it has been paying appreciable dividends for the efforts expended.

Much time was saved and speculation avoided by preparing and maintaining this schedule and, considering that over three hundred motors formed the basis of this system, its success cannot in any way be termed exaggerated.

The first step in this work was to begin with the motors on the top floor. The instructions were to examine and oil them if necessary and make a memorandum of the attention that was given them on this occasion. Brush conditions also were noted and, apart from wiping the outside of the motors and sandpapering the commutator if necessary, very little cleaning was done. The oiling schedule was pushed because it was of the greatest importance, especially as it is a well-known fact that apart from hearing the tinkle of a dry oil ring, placing the hand on the motor end over the bearings, or by visual observation, there is no way of knowing that a running motor is dry until the bearings smoke, seize, or melt. But short brushes can be detected by excessive sparking well in advance of the critical point where they cause the motor to stop by blackening the commutator and preventing good brush and commutator contact. Since more than 53 per cent of the motors were ceiling-mounted and not quickly or easily accessible, the importance of a speedy and accurate oil-condition survey was well established.

After two weeks of this floor-to-floor work, all motors from the top floor to the basement were brought into the preliminary line of the oiling schedule. Then the work was started over again in the same order, and a record of oil conditions was made as before. By keeping a constant check of the oil consumption and making comparisons between oiling and oil-inspection periods, it was an easy matter to determine just how long the motors in any location could run without attention as far as lubrication was concerned. The end of the second two weeks found the system showing promise, and oiling schedules then were established for a few floors.

On several floors there were more motors than could be taken care of on a single date. It therefore became necessary to divide them into groups according to their locations, such as north and south wings, north and south mains, and main of their respective floors.

A few motors with defective bearings or other troubles pertaining to lubrication which caused them to re-

(First two weeks preliminary of (1) motor oiling schedule.)

Date	Floor	Remarks
1925 Jan. 2	11 - - -	all motors oiled. #1165 very low. Special attention.
" "	10 S.W.	" " "
" 3	" S.M.	No oil required
" 4	" M.	" " "
" 5	" N.M.	all motors oiled. #1091 running hot. Special attention.
" "	" N.W.	" " "
" "	9 N.W.	No oil required.
" 6	" NM, SM, M, SW.	" " "
" "	8 - - - -	all motors oiled. #834 dry. Special attention.
" 7	7 - - - -	No oil required.
" "	6 - - - -	" " "
" 9	5 - - - -	50% required oil. #525 dry. Special attention.
" "	4 - - - -	No oil required.
" 10	3 - - - -	" " "
" 11	2 - - - -	all motors oiled.
" 12	1 + bin't	No oil required.
" 13	outside nos.	" " "

A record of the first two weeks progress in making the oiling schedule. All motors were examined and notes made of unusual lubricating characteristics.

quire frequent attention were noted "for special attention" until the necessary repairs or replacements were made. Then they were included in the schedule for the other motors of the same location.

Over twenty motors driving fans, blowers, and exhausters on seven floors were placed on a separate schedule instead of being included with the other motors on the same floors or locations. This separation was occasioned by their intermittent operation.

The progress of the system was recorded on 5x8-in. ruled cards. The first card covered the first two weeks and was headed "First two weeks preliminary of motor oiling schedule." It showed that all the motors were examined and that notes were made of unusual conditions regarding their lubrication.

The second card, headed "Second two weeks preliminary of motor oiling schedule," is Feb. 1, a period of 16 days. Then, after the attention to the motors on this floor was completed, the date was checked, remarks made, and the next oiling date noted.

It is clear to see how much easier it would have been to get such a system in working order quickly if it were begun immediately after a plant placed its motors in service.

This schedule or oiling system, if faithfully followed, should enable anyone in charge of motor maintenance in any plant to know his motors and anticipate just how much and when they require attention.

Loss of Oil

In a particular case, a 2-hp. motor required daily oiling at the pulley-end bearing. A heavy grade of oil would not remain in the bearing any longer than the lighter grade previously used. Examination showed that the belt from the motor to the machine was so tight that the friction between the shaft and the bearing caused the oil to boil out. After the belt was slackened, oil was retained for two weeks without reaching a critically low stage.

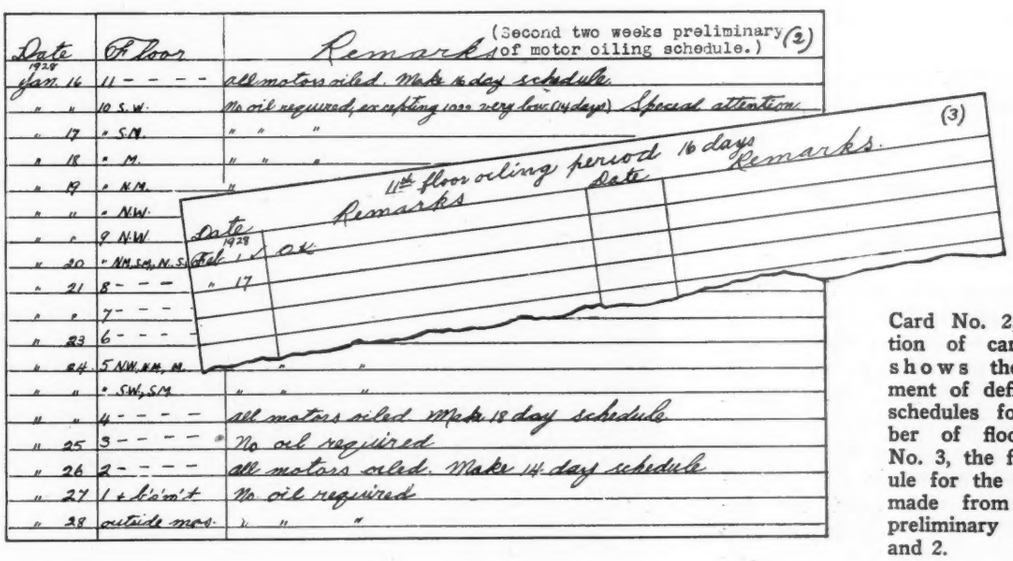
Another case where oil would not remain in a similarly located bearing was occasioned by the clogging of a $\frac{3}{8}$-in. space between a cap sleeve and the outer end of the bearing. With the clogging of the space where the oil should fall from the shaft back into the oil well, the oil followed along the shaft, and out onto the floor. A remedy was effected by cutting away about a half of the lower inner portion of the sleeve.

In following this system, it has been found that visual observation of oil indicators is not always a reliable means of determining the true conditions of the oil wells of motor bearings. In a particular case some foreign matter entered the oil indicator of a 15-hp. floor-mounted motor. It sank to the bottom and cut off the oil in the indicator from that in the oil well. Then, of course, because the indicator showed a full well, no oil was added until the bearing become excessively hot.

To avoid a repetition of this condition the indicators are given a periodic cleaning by inserting a short piece of No. 14 soft-drawn wire into them and drawing it back and forth a few times. Whenever there is an occasion to take off either or both motor ends, the bearings are washed with hot water and thoroughly dried before they are replaced.

Several of our motor-driven blowers and exhausters are direct connected by flexible couplings and have independent bearings without oil indicators. The bearings are oiled the same time as the motors. Some of this apparatus, especially where a single bearing is used near the coupling, requires very little oil because the shaft generally floats or rests lightly upon its own bearing.

Care is taken when oiling ceiling-mounted motors while they are running to make sufficient allowance for the oil that will run back from the oil rings after they have stopped. In some cases, according to the size or the number of rings, the oil level in the indicator drops $\frac{1}{2}$ in. when the motor is running, while in other cases the drop is hardly perceptible.


Date
Floor
Remarks
(Second two weeks preliminary of motor oiling schedule.) (2)
1928
Jan. 16 11 - - - - all motors oiled. Make 16 day schedule
" " 10 S.W. No oil required, on sighting was very low (14 days) Special attention
" 17 " S.M. " " "
" 18 " M. " " "
" 19 " N.M. "
" " " N.W.
" " 9 N.W
" 20 " NM, SW, N.S.
" 21 8 - - -
" " 7 - - -
" 23 6 - - -
" 24 5 NW, NM, M.
" " " SW, S/M " " "
" " 4 - - - - all motors oiled Make 18 day schedule
" 25 3 - - - - No oil required
" 26 2 - - - - all motors oiled. Make 14 day schedule
" 27 1 + b'm't No oil required
" 28 outside mot. " " "
11th floor oiling period 16 days
Date
Remarks
(3)
Date
1928
Feb 1
ok
" 17

Card No. 2, a repetition of card No. 1, shows the development of definite oiling schedules for a number of floors. Card No. 3, the final schedule for the 11th floor, made from data on preliminary cards 1 and 2.

ing schedule," is a repetition of card No. 1, and shows the establishment of the schedule for the eleventh, eighth, fourth and second floors, with an oiling period of 16, 17, 18 and 14 days respectively.

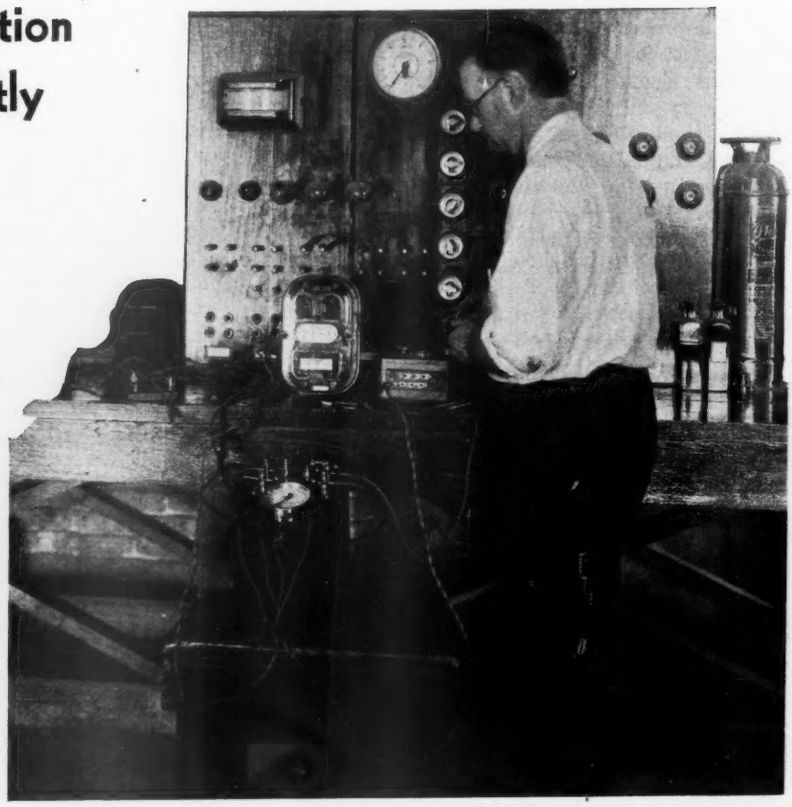
This process of elimination was continued until the system was completed and schedule cards made out for each floor or section. Because of the small number of motors located on some of the floors, it proved convenient to group as many as three floors on a single card.

Card No. 3 is an example of the oiling schedule for the eleventh floor. The first oiling date for this floor calculated from Card No. 2, "Second two weeks preliminary of motor oil-

Make Your Meters Tell the Truth!

Inaccurate registration may conceal costly power losses

J. ELMER HOUSLEY
Alcoa, Tenn.



Good facilities make for satisfactory meter testing, without which accurate cost accounting is impossible.

A METER-TESTING department in an industrial plant may be made a simple and inexpensive facility. The average plant using alternating current will have a number of recording or indicating meters for testing motors and feeder loads and one or two meters for measuring voltage, which are seldom tested at the plant. These meters are sent to a laboratory or returned to the manufacturer. Primarily, the principal work of the meter-testing department will be found in the testing and repair of integrating watthour meters.

An adequate room in a clean location should be provided for the storage and bench testing of new and repairable meters. In it, storage facilities may consist of shelves or suitable racks in addition to a substantial bench about 12 ft. long, having a back board for mounting meters, switches, and other necessary equipment. Sources of current of the proper voltages also must be provided.

For ordinary work the essential test equipment may consist of a single-phase load box and a polyphase rotating standard watthour meter. The polyphase type with multi-voltage and multi-current ratings is often selected for convenience in field testing where the meter is to be tested in place. Although a phase-shifting device is sometimes used in laboratory testing, its use is more or less governed by local conditions in industrial-plant testing. If the meters operate at light load for a considerable period measuring the magnetizing current of transformers, it is necessary to test the meters at low power factors, a procedure which requires the use of a phase shifter to obtain the various power factors in the testing circuit. About the only tools required are contained in a pocket kit that is offered by manufacturers of watthour meters, in which cleaning brushes, oil, tweezers, needles, small pliers, and the necessary wrenches are included.

Before one can master the essentials of meter-test procedure it is important to know some of their inherent troubles and remedies. Dirt and transient voltages are two natural enemies of watthour meters after they are in operation. Dirt wears or roughens bearings, causing incorrect registration. Transient voltages, such as lightning, cause breakdowns of insulation. Meters should not be installed where they will be subject to constant vibration which causes damage to jewels, breaking of delicate wires, and inaccurate registration. Excessive vibration may loosen parts and cause rubbing or binding.

Exposure to excessive humidity, to excessive temperature changes, and to corrosive vapors and fumes must be avoided.

Setting a hard and fast schedule for meter testing, and subsequent repair

and adjustment, is rather difficult; however, good results are possible with frequent checks, increasing the interval as the meters are found to retain their accuracy and good condition. For one particular condition a schedule has been prepared wherein the test period for important meters at the principal points has been set at three months.

In selecting the personnel for handling the work it is important to recognize that the responsibility should be carried by one man. A single individual may supervise such a department for quite a large plant, and, at the same time, carry on other work such as complete motor tests, circuit tests to determine the loading of transformer banks and distribution centers, likewise loading and voltage-regulation tests of lighting circuits.

MADE IN U. S. A.
421 1M-10-25

METER TEST RECORD

MFG.			SERIAL No.
LOCATION		VOLTS	AMPS.
WIRE	PHASE	TYPE	CYCLE
METER CONSTANT		READING	

CONDITION OF METER

CASE	DIAL	SEAL	JEWEL
GEARS	MAGNETS	DISC	CREEP

CURRENT TRANSFORMERS		POTENTIAL TRANSFORMERS	
MFG.	TYPE	MFG.	TYPE
SERIAL No.	RATIO	SERIAL No.	RATIO
VOLTAMPERES	CYCLE	V. A.	VOLTAGE

REMARKS

TESTER

A type of meter test-record card that is now in almost universal use. There is space on the reverse side to contain the results of twelve successive tests.

Individual supervision of all meters is possible in a large plant, providing the essential equipment is provided.

This kind of work is fully justified when the benefits are checked against the cost. However, the results must be watched by the department head, and the tester must have an intimate knowledge of the plant's operating equipment.

How the system as a whole functions may be illustrated by an example. In a process plant the power to each department was metered. One month (*July*) the power to the evaporation department increased from the usual 60,000 kw.-hr. to 90,000 kw.-hr. A check on the meter indicated that it was correct. Also, the meterman investigated the operation of the equipment which consisted entirely of centrifugal pumps. He found that during the month two pumps instead of one had operated to supply cooling water to the condensers. The operator was endeavoring to improve his vacuum conditions which were disturbed by the increased temperature of the cooling water during the hot weather. The electrical department assumed the burden of proof to show the operating department that the second pump did not materially increase the volume of cooling water. A flow meter placed in the discharge header indicated a 5 per cent increase in water pumped by operating both pumps as compared with one pump, although the power consumed by both pumps was 190 per cent of that required for a single pump.

As a matter of fact it was found later that the pumps were not designed for parallel operation, al-

CAUSES OF INCORRECT REGISTRATION

	SLOW	FAST
5 per cent or less	Worn jewel Dirty magnet Adjustments shifted	Adjustments shifted Magnets weak Vibration changing friction Short circuit in coil
10 per cent or more	Defective potential coil Friction in register Potential fuse blown Dirt or scale on disk Short-circuited current coil (main)	Defective magnets (very rare)

though when checked against the test results the characteristic curves of the pumps were in agreement.

It is not sufficient that the personnel of the meter-testing department content itself with the mere checking of the meters when such an avenue of service beckons. An analysis of the monthly reading of the watthour meters in each department presents many interesting problems anent power waste.

■ ■

BOOKS

(Continued from page 557)

8, Automatic Overload Protection of Circuits and Appliances. Section 808 covering Motors and Circuits has been materially revised. New subdivisions apply to feeders of motor branch circuits and to secondary circuit conductors for wound-rotor, a.c. motors.

Changes in Section 906, Grounding Portable Equipment, provide better protection in portable appliances at voltages higher than 150 volts and in permanently moist locations.

Text for Article 18, Storage Batteries, has been completely rewritten.

Section 1901 of Article 19, Lightning Arresters, has been completely revised and made applicable to industrial stations.

In Article 32, Hazardous Locations, a new paragraph (d) of Section 3201 defines Class 4 locations as places where ignitable combustible fibers are stored or handled.

■

Building Code

Printed by the National Board of Fire Underwriters, 85 John St., New York, N. Y. Fifth edition. Cloth, 316 pages, illustrated. No charge.

THE FIRST edition of the National Board Building Code, which embodies the recommendations of the National Board of Fire Underwriters in respect to good and safe practice in building construction, appeared in 1905. Since then three revisions have been made in the Code, to keep up with changing conditions in the building industry. The present edition represents a thorough revision, with the inclusion of the best thought on building construction and reduction of fire hazard.

This recommended Code presumes to regulate all matters relating to the construction, alteration, removal or demolition of buildings or structures.

■

Electricity, What It Is and How It Acts — Vol. II.

By Andrew W. Kramer, Associate Editor, Power Plant Engineering, *Chicago, Ill. Technical Publishing Company, 53 West Jackson Blvd., Chicago, Ill. Cloth cover, 290 pages. $2.*

THE FIRST volume of this work appeared late in 1929, and was reviewed in the January, 1930, issue of *Maintenance Engineering.* It discussed the underlying laws and fundamental principles of electricity. Volume II. carries the treatment into a consideration of radiation phenomena of various kinds.

The book is not "practical," that is, it does not seek to present applications of physics and electricity; its aim is rather to interpret the more recent theories concerning the nature of matter advanced by mathematical physicists. It has been said that our scientific specialists are a century or two ahead of "the man on the street," in their conception of the physical world.

The average man has neither the training nor the leisure to keep abreast of things scientific. Therefore a book like this serves a valuable purpose by summarizing recent theories and hypotheses, and by translating the results of abstract mathematics into every-day English. Thus, "Electricity, What It Is and How it Acts" does not attempt to show rigidly *how* men like Jeans and Eddington have arrived at their conclusions, but rather, what these conclusions are. The book is richly illustrated with photographs and diagrams.

■

Electrical Equipment

By Harold W. Brown, formerly of the Department of Electrical Engineering, Cornell University, Ithaca, N. Y. McGraw-Hill Book Company, 330 West 42nd St., New York, N. Y. $5.

ALTHOUGH much of the material in this book is of a general nature, of interest to any plant man having to do with electrical equipment, it seems especially suitable for the library of the power, transmission, or distribution engineer. It fills a needed place in technical literature, because it gathers together for easy accessibility information and illustrations of a large variety of equipment. Although, as indicated, the electrical utility engineer will find this book of more value than the plant man, the sections on electrical measurements, heating and welding, and motor applications are of a general instructive nature. The section on cost of apparatus is especially to be commended for study.

■

Principles of Direct Current Machines

By Alexander S. Langsdorf, Director, Department of Industrial Engineering and Research, and Dean of the Schools of Engineering and Architecture, Washington University, St. Louis, Mo. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York, N. Y. Fourth edition, cloth bound, 586 pages. $4.50.

THE FIRST edition of Professor Langsdorf's book appeared in 1915. The latest edition is substantially the same, with added material to bring the whole up to date. The new matter includes a treatment of equalizer connections in multiplex windings, motor starting devices and rheostats, original constructions of motor and generator characteristics, and a comprehensive treatment of the mechanics of motor acceleration and retardation. In connection with the last-named, the author's three-dimensional graphs are are of especial value. The subject of commutation is gone into very thoroughly. Each chapter throughout the book closes with a series of problems for the student.

QUESTIONS and ANSWERS

Please submit answers promptly. We expect to publish no answers later than the second issue following the appearance of the question. Selection will be made on the basis of quality, but answers first received have the best chance of being used.

◆

High-Gloss versus Flat Paints

I should like to know whether paints that dry with a comparatively high gloss are more or less suitable than so-called flat paints for use on the walls and ceilings of industrial buildings. I have in mind such factors as light-reflecting ability, tendency for dust and dirt to adhere to the surface, ease of cleaning, and general durability. What conclusions have readers come to in this matter?

St. Louis, Mo. **E.O.E.**

■

Removing Ventilating Fans from Armature Shafts

I should like to know (1) the method that readers have found to be the most practical for removing the small stamped or cast ventilating fans from the end of an armature, preparatory to rewinding. (2) When rewinding d.c. field poles should poles of opposite polarity be obtained by reversing the leads when connecting up the winding, or by reversing the direction of the winding on the pole? **G. A. L.**

Brooklyn, N. Y.

■

How Prevent Cracking of Skylights?

Cracking of skylights without apparent reason is causing us considerable trouble. They are all of ¼-in., wire-reinforced glass with an average size of 18x48 in. Some of the glass is in an almost horizontal position on a flat roof, whereas other lights are installed in steel framework at a 30-deg. angle.

The machinery in the building does not cause severe shocks. However, about three miles away considerable blasting is being done. The earth formation around here is limestone and sandstone. Because of the noise made by our machinery we have never been able to detect blasting shocks in the building, but these shocks may readily be detected throughout the city. Can anyone tell me how we can prevent cracking of our skylights?

Joliet, Ill. **G. P.**

What To Do if the Synchroscope Fails

We have two 550-volt, 60-cycle generators that are operated in parallel part of the time. We use a synchroscope for putting the machines together. There has been no trouble with this instrument, but I understand that they do sometimes fail, and should like to know what would be the simplest and best procedure to follow in paralleling our generators in case the synchroscope goes bad.

J. E. L.

West Warwick, R. I.

IN CASE the synchroscope fails or the synchronizing lights go out so that it is impossible to tell whether the generators are in step, the following method can be used. It is very simple and will put the incoming machine on the line without the least trouble, or danger by bumping it.

Bring the incoming machine up to as near synchronous speed as possible and, without field excitation, close the generator oil switch or breaker. This will connect the armature to the bus and if it is below synchronous speed it will speed up, as the machine will now tend to operate as an induction motor. With the generator field resistance nearly all in, close the field switch, which will start to build up the field on the machine, gradually build up the voltage, and smoothly pull the machine into step. Adjust the field to the required strength by cutting out the resistance slowly.

This procedure has been tried on many different sizes of alternators and has given good results. GEO. DREYER.

Peoria, Ill.

GENERATORS can be paralleled by means of synchronizing lamps, if the synchroscope fails. The conditions necessary for paralleling are that the voltages must be equal, instantaneously opposite, and of the same frequency. It is very important that the voltages be brought as nearly equal as possible before any attempt is made to tie the machines together.

Lamps are placed across the phases of the generators, either directly or through potential transformers; the latter is the usual method in the case of generators rated above 220 volts.

In the present case two potential transformers rated 1,100/110 volts can be placed in open delta across the phases of each of the generators (the reason for the 10 to 1 ratio when using 110-volt lamps is that the maximum voltage will be twice the generator voltage). One 110-volt lamp can then be placed in each of the connecting lines, on the secondary sides of the potential transformers.

As the two machines approach synchronism the lamps will be alternately luminous and dark, and the nearer synchronism is approached the more slowly will the lights change. The frequency of change will be the difference in the frequencies of the two machines. When the lamps are dark for several seconds synchronism is indicated and the main switch may be closed. A modification of the above method is to cross two of the phases with the lights in them. Then instead of all of the lamps dimming at once they will dim in rotation (the direction of rotation depending upon the relative speeds of the machines) and at synchronism those in the crossed phases will remain at their maximum brightness, whereas the remaining light will be dark.

An advantage of the crossed-phase method is that if anything happens to the lamps it will be noticed quickly, whereas in the first method burnout of all the lamps might be taken by the operator to mean that the machines are in synchronism.

This method is given in order to avoid error in phase rotation. When synchronizing three-phase generators for the first time it is necessary to synchronize at least two of the phases. If a single phase alone is synchronized the other two phases may be 120 deg. out of phase. After the connections have been made and found to be correct, synchronizing of one phase is sufficient. In spite of this it is customary to provide synchronizing lamps for all three phases.

It is also possible to use a voltmeter for synchronizing, instead of lamps. When the voltage between the machines

is zero, it is equivalent to the darkening of the lamps and indicates that the two machines are in synchronism.

The synchroscope is, of course, much more accurate than indicating lamps, but the methods described above can be used in case of emergency.

St. Louis, Mo. A. G. VIOLA.

■

What Causes Unbalance in Phases of Motor?

Two of our 440-volt, three-phase, squirrel-cage motors show an unbalanced running current when an ammeter is put in each leg. On the bench, the resistance of all phases, measured from lead to star, is identical. Also, the current taken by each phase, with the rotor removed, is the same. What causes this unbalance? Another question. What is the surest way of detecting a reversed coil in a three-phase stator? I have not had much success with the compass method, as the other coils of the same group more than offset the opposite polarity of the reversed coil; hence, the needle does not reverse. **C. H. F.**

Lomita, Calif.

THE FACT that the motor takes an unbalanced current when running, and a balanced current when the rotor is removed, shows that the reluctance of the three circuits is different.

This condition can be caused by a reversed coil, or by one of the coils having a large number of turns of coarse wire. In either case the resistance by the Wheatstone Bridge would be the same with rotor in place or removed. When testing with alternating current, the difference might not be detected with the rotor removed, but would show up with the rotor in place.

A careful check of the different coils will show which coil is reversed. Mark each coil with an arrow of colored chalk, using different colors for the coils of different polarity. Exciting the stator with direct current and testing with a piece of metal such as a nail, should also show which coil is reversed. A compass is of very little use because the other coils affect it and sometimes even reverse the polarity of the needle. If a nail is laid parallel to the slots in an excited stator it will not move if the coils are of the same polarity. If the polarity differs (from a reversed coil or a change in poles) the nail will not remain quiet but will turn into such a position that the ends will lie on coils of different polarity.

Sometimes there are other reasons outside of the motor, such as unbalanced voltages, that cause trouble like this, but such conditions would probably affect all motors on the same circuit or set of transformers. CHAS. O. RANKIN.

K. W. Manufacturing Co.,
Ontario, Calif.

I ADVISE checking the internal and external connections of the motors. A loose or poorly soldered joint in any of these connections will give unbalanced current on the three phases. This condition may show up only when the motors are carrying their rated loads.

To test for shorted or reversed coils we connect the stator to a three-phase line carrying one-half or the full voltage of the motor. Using a rotor consisting of an ordinary can with a rod through both ends as an axis, we watch the coils closely, as they will warm up quickly. A shorted or reversed coil will heat up more quickly than the others and can be distinguished easily.

In testing we have also used a 1-in. ball from a ball bearing, allowing it to run around the inside of the stator. A shorted or reversed coil will cause the ball to stop on that coil.

All of our motors up to 40- or 50-hp. rating, 220 or 440 volts, are given these tests and an additional ground test before the final dipping and baking after repairs. THOS. M. GUIER.

Universal Electric & Manufacturing Company
Johnstown, Pa.

■

Using Hydrogen for Lead-Burning

Our lead-lined acid tanks sometimes develop leaks, and it is impracticable to use a wiped patch. Leaks in the bottom are easily puddled in with an acetylene torch, but are difficult to repair on the sides, as the flame oxidizes the lead. We built a hydrogen generator, using zinc and sulphuric acid, and obtained better results, but still get an oxidizing flame. Will some reader who has made a hydrogen generator tell me how he did it; also, whether he uses oxygen with the hydrogen?

Providence, R. I. **R. E. T.**

WE HAVE been repairing lead-lined tanks for a number of years and have always obtained satisfactory results by using an ordinary oxygen and acetylene torch. There is no advantage in using hydrogen for this purpose. An oxidizing flame is caused by an improper gas mixture; a neutral flame can be obtained by using less oxygen.

It is almost impossible to repair the side of a lead-lined tank if the welder attempts merely to stick a patch over the bad place. The best procedure is to cut a slit in the lining at the bottom of the worn spot and work the patch under the lining itself. This procedure makes the patch much easier to burn and gives a better-looking job when the repair is completed. C. W. SCHWABE.

Superintendent Mechanical Department
Mallinckrodt Chemical Works
St. Louis, Mo.

■

Why Does This Armature Heat?

We have encountered trouble in changing the armature of a Westinghouse type SH, 220-volt, d.c. motor for 110-volt operation. The armature has 49 slots and 97 bars. Original coils were wound with four turns of one No. 11 wire; coil span, 1 and 12; lead span, 1 and 50. In rewinding we used two and three turns per coil of two No. 11 wires in parallel. On bar-to-bar and growler tests the armature checked OK, but after running 15 min. without load it became very hot. The coils were made in an outside shop, and I am wondering whether a mistake was made in putting sleeves on the two- and three-turn coils.

New Orleans, La. **E. J. R.**

EVIDENTLY this is a four-pole machine, and has four brush-holders. If the armature were free from shorts and grounds in the first place, it could have been reconnected for 110-volt service without rewinding.

Inasmuch as it was decided to rewind the armature, two No. 11 d.c.c. wires in parallel should have been used, with two turns per coil (not two and three turns per coil), and 1 and 50 connection. The field coils (both shunt and compound) should have been connected series-parallel.

If the windings were old, and the service to be performed by the motor is very important, it would have been best to rewind the machine completely for 110-volt operation, as follows: For the armature, select a wire having twice the current-carrying capacity of one No. 11 and use two turns per coil. Connect 1 and 49 or 1 and 50 (depending on the direction of rotation). For the shunt fields, use the same weight in pounds of a wire having twice the original cross-section. For the series fields use one-half the number of turns of a wire having twice the current-carrying capacity of the old wire. Connect the coils in series, as originally.

In any case the horsepower output and speed will remain the same, but the current taken by the motor will be doubled; hence a new nameplate with the new data should be made and put on next to the manufacturer's nameplate.

Harlan, Ky. C. L. UMBERGER.

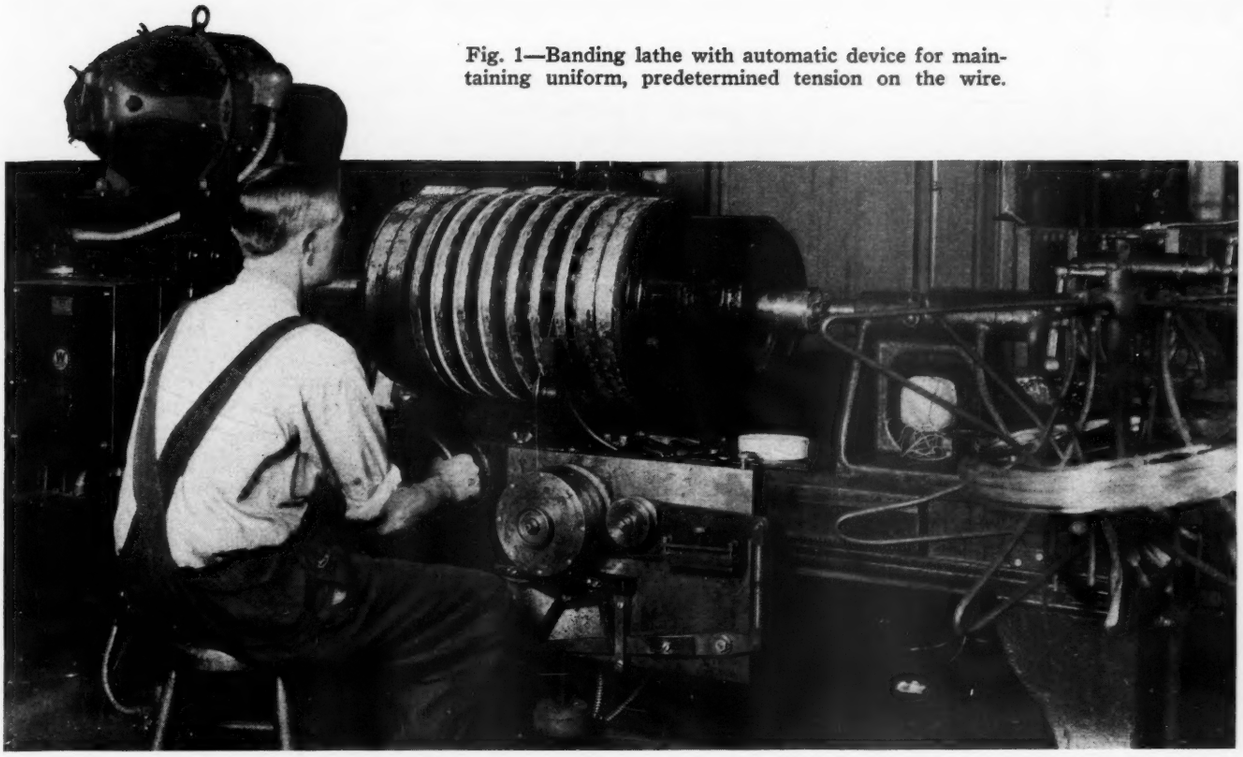


Fig. 1—Banding lathe with automatic device for maintaining uniform, predetermined tension on the wire.

Wire Tension for Cold Running Bands

A. C. ROE

Renewal Parts Engineering Department
Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

MOST direct-current armatures and wound rotors for alternating-current motors that use steel-wire retaining bands have these bands applied by what is termed the "cold running band" method. The word "cold" denotes that the bands are applied to the armature at room temperature. Likewise, the term "running bands" denotes that the armature or rotor is revolved and the wire is applied one turn at a time, each band being one continuous length of wire.

The tension applied to the wire during the application of running bands to either a cold or a hot armature is of great importance. It is varied according to the diameter and kind of wire used, the type of coil support, type of coils, and so on.

Tension on banding wire may, for all practical purposes, be considered from two standpoints: First, the tension to be applied to the various types of windings; second, the method of establishing and maintaining the proper tension on the wire during its application to the rotor.

The tension applied to the banding wire is governed by several factors, such as grade of wire, diameter of wire, whether the coil ends are supported or unsupported, peripheral speed of the rotor, type of service, and type of coil. After considerable study, standard tension devices have been developed and the proper wire tension for various types of armatures established. Some of these values are given in Tables I, II and III, for easy reference.

Table I applies to armatures up to 21-in. diameter with the coil ends unsupported. The pounds tension is varied according to the armature diameter and size of wire. Tables I and II apply to the motors commonly used in industrial service.

Table II applies to armatures up to 21-in. diameter with the coil ends supported. It will be noted that the size of wire is larger and the tension greater than in the case of unsupported end windings.

Table III applies principally to railway and mining motors, and is divided into two parts: one for windings employing armature coils wound from round or square wire, and the other for coils wound with ribbon or strap copper. This table also gives the tension for each layer of multi-layer bands. Thus, Tables I to III should enable one to select a wire size and suitable band tension for most cases.

After establishing the best tension for the various types of windings the next important step was to develop a method of insuring uniform tension during the application of each

TABLE I — WIRE TENSION FOR SMALL ARMATURES WITHOUT COIL SUPPORTS

Diameter of Armature	Diameter of Banding Wire — 0.029 In.	0.045 In.	0.064 In.
	Pounds Tension on Wire		
Up to 7½ in.	35	...	....
7½ in. to 10 in.	50	...	....
10 in. to 13 in.	..	100	....
13 in. to 16 in.	..	125	....
16 in. to 19 in.	..	150	200*
19 in. to 21 in.	..	....	250

* Used on rotors 18 to 19 in. in diameter with heavy coil ends. Preferable when conditions permit.

TABLE II — WIRE TENSION FOR SMALL ARMATURES WITH SOLID COIL SUPPORTS

Diameter of Armature	Diameter of Banding Wire — 0.045 In.	0.064 In.	0.081 In.
	Pounds Tension on Wire		
Up to 7½ in.	100	...	...
7½ in. to 10 in.	125	...	...
10 in. to 13 in.	...	150	200
13 in. to 16 in.	...	175	250
16 in. to 19 in.	...	...	300
19 in. to 21 in.	...	...	350

turn of all bands on any armature. Fig. 1 shows a banding lathe with a tension device which the operator can set at a predetermined wire tension. Control lights warn him when the tension varies from the desired value. This device is automatic and has the advantage that the tension is not obtained by friction on the wire itself; thus, even with high wire tension the wire is not heated, and its tensile strength is not affected.

Tension is obtained through a friction drum around which a few turns of wire are wound, and weights are used to obtain the desired setting. In Fig. 2 is shown the working parts of the tension device developed and used by the Westinghouse Company and its service shops. The tension drum is next to the carriage handwheel; the tension weight is attached to the bottom of the friction arm. The small clamp through which the wire first passes smoothes it out and guides it.

The control for the tension device is shown in Fig. 3. Two small lights, one red and one green, are mounted at the left of the operator under the motor and just above the outlet plug. The green light is on at all times, when the band tension is correct. If the tension varies from the desired value the red light shows.

The foregoing discussion indicates the importance that the large electrical companies attach to the matter of establishing and maintaining proper band tension, without putting friction on the wire.

Cold running bands can be divided into two types: (1) Temporary cold bands. (2) Final cold bands.

Temporary cold running bands are used to set the windings; that is, take up the looseness, and provide a solid structure that will permit other operations, such as soldering clips or commutator necks, wedging, and so on, to be performed.

The type of armature or rotor and the operating conditions will determine whether the temporary bands should be applied to the coil ends only, or to both the core section and coil ends. For example, on partially closed slot rotors, it is the practice to apply temporary bands to the coil ends only, whereas on open-slot armatures that are wedged it is customary, when a tight winding is desired, to apply maple sticks in the slots on top of the coils. The sticks project above the core surface so that the coils can be pulled down. On other types of armatures, grooves are cut in the core for core bands, and the tops of the coils should project $\frac{1}{32}$ in. to $\frac{3}{64}$ in. above the surface of the core in the band groove. Maple sticks can be

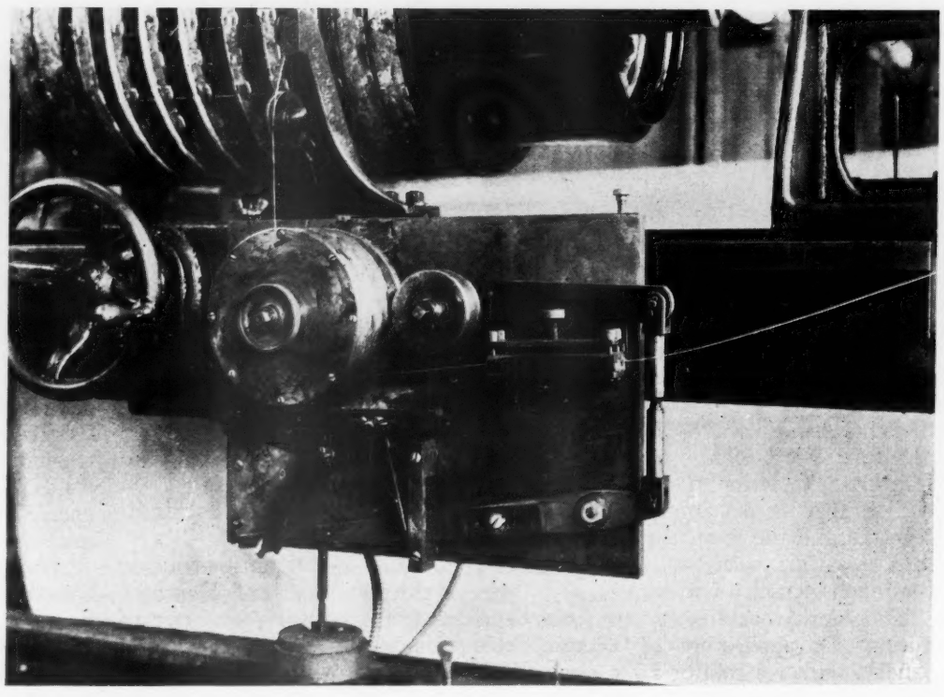


Fig. 2 — Close-up view of the tension device on the banding lathe shown in Fig. 1.

used in the slots on top of the coils, or the temporary bands may be applied in the grooves only.

In general, temporary bands should be applied to all rotors that attain in service a peripheral speed of 8,000 ft. per min. or more; to rotors having front and rear coil supports, before soldering and wedging; to rotors before attaching the cross connections at the rear; and where maximum solidness is desired.

The process of cold banding can be divided into six operations: (1) Truing the coil ends. (2) Placing the insulation and anchoring the clips. (3) Temporary banding. (4) Permanent banding. (5) Soldering the bands. (6) Finishing bands. Only operations 1 to 4 will be discussed.

TABLE III — WIRE TENSION FOR RAILWAY AND MINING MOTOR ARMATURES

Type of Winding	Layers of Bands	Diameter of Banding Wire — 0.029 In.	0.045 In.	0.064 In.	0.081 In.
		Pounds Tension on Wire			
Wire-Wound Coils	1	100	200	250	...
	2	75	150	...	...
	3	50	100	...	...
Strap- or Ribbon-Wound Coils	1	100	200	400	550
	2	75	175	350	...
	3	50	150	300	...
	4	...	125	250	...
	5	...	...	200	...

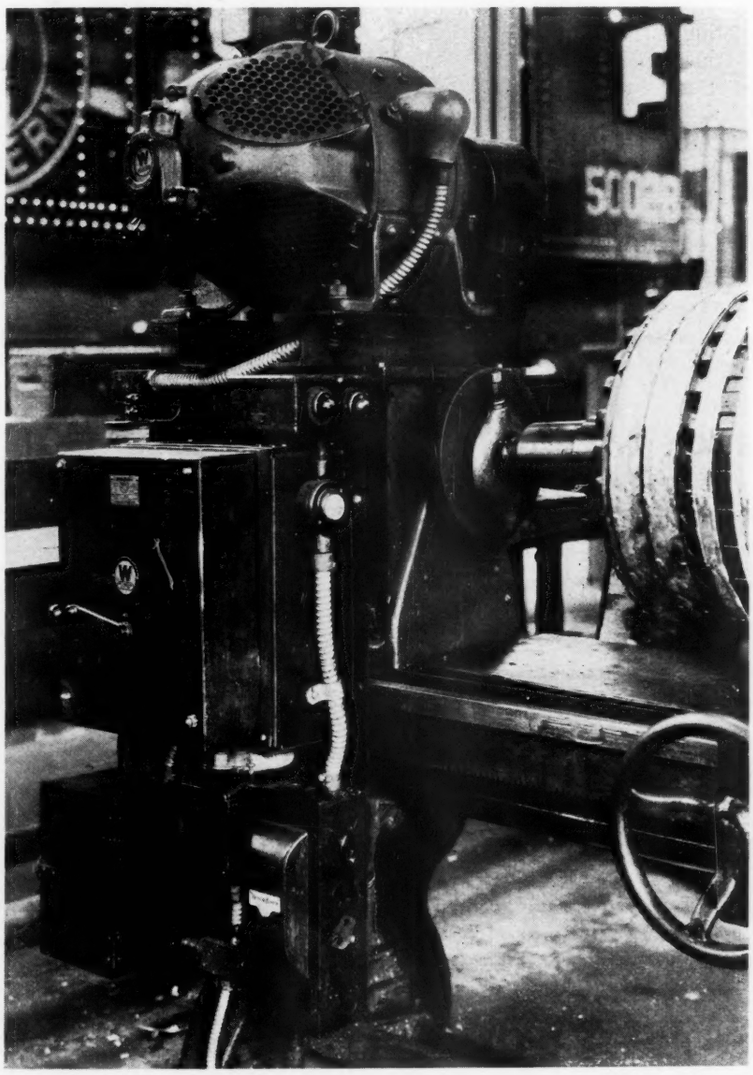


Fig. 3—Control and indicating lamps for operator. The lamps are located below the motor. A green light indicates proper tension on the wire; the red light shows when the tension varies from the desired value.

In truing coil ends, the end windings are formed into a true concentric circle about the shaft by tapping the high spots down with a mallet. High spots can be located by using chalk on a steady rest and spinning the armature. It is important that the bands exert pressure on each coil end; do not allow one or more coil ends to sag below the others. All coil ends must be pulled down sufficiently to keep the surface of the bands below the core.

With ventilated windings, apply filling strips between adjacent coil ends, under the band area. These fillers must fit snugly, but not tightly enough to cause the coil ends to arch-bind before the ends are pulled down tightly against the coil supports. If coil supports are not used, the fillers or spacers must fill the periphery to permit arch-binding when the winding is banded.

If the armature is to be temporary-banded, apply sufficient insulating material to protect the coils from damage. For the final bands apply a few turns of twine to the band area, and under the string band apply the required insulation. Also, place the holding clips on top of the insulation and space as outlined previously.

For temporary banding use 0.064-in. or 0.081-in. diameter wire, with 25 per cent greater wire tension than is required for the final bands. On the coil ends use solid bands, and when the armature is to be wedged after temporary banding apply the end bands as close to the core as possible. When temporary bands are applied over the core section, a number of $\frac{1}{2}$-in. wide bands spaced closely, or one continuous band with turns spaced $\frac{1}{16}$ in. or $\frac{1}{8}$ in. apart, can be used. Be sure to drive out all looseness in the winding as the bands progress across the core.

When applying temporary bands to the core and end windings, care should be taken that, in starting at one end of the armature and working straight across, the winding is not rocked; that is, one end pulled down too tight. One method of preventing

this is to apply the core bands first, one at each end of the core; return to the starting point of the first core band, and then progress across the armature and cut off the preliminary end core band and reband. Lastly, band the coil ends.

When applying the final bands, start on the core and obtain the correct wire tension by running a few turns on the core until the tension is adjusted. Apply the core bands first, and if the armature has not been temporary-banded, apply a band on opposite ends of the coils to prevent rocking. Then fasten the ends of each band by turning over and soldering at least two clips. Do not cut the wire, or release the tension.

The same tension is used on the wire for all bands, regardless of whether they are on the core or coil ends, and each turn should be kept tight against the preceding turn. When insulation is used under bands be sure to allow sufficient space between the starting and finishing turns of the band and the edge of the insulation to provide adequate creepage space.

When more than one layer of bands is used, the tension is reduced for each additional layer, as indicated in Table III. Care should be taken to see that the bands are insulated and divided into sections according to the data given in previous articles.

When no coil supports are used it is permissible to use anchoring clips between the end core band and coil end bands. These clips should be spaced not less than 16 in. apart, and it is advisable that one end of the anchor clip be insulated from the band to prevent the development of circulating currents.

The important items in cold banding are: trueness of the end windings, (they should be round, not concentric); proper tension; pulling the coils into compact mass; filling between adjacent coil ends to prevent collapse; maintenance of the proper tension on the wire for all turns of each band, without heating the wire.

Planned Maintenance Means Reduced Costs

C. W. SCHWABE
Superintendent, Mechanical Department
Mallinckrodt Chemical Works, St. Louis, Mo.

MORE work with fewer men is the direct result of modern methods and machinery and also the boast of almost every production manager. Yet, in many plants where production is the last word in efficiency, the maintenance department struggles along in a haphazard and unorganized manner and is generally regarded as a necessary evil. A little thought given to the handling of maintenance work will frequently disclose the fact that very worth-while savings can be effected and greatly improved service can be obtained if this work is properly planned and organized.

A few simple changes in the planning system in our plant permitted a 30 per cent reduction in the maintenance force. Even with the smaller crew, more jobs were handled and the work was done in less time. Formerly, the orders for mechanical work were okeyed by the maintenance department head and then passed on to the foremen of the various shops. These foremen were supervised by a master mechanic. The preference given to any order was largely in his hands.

Under our present system all orders pass through the hands of the maintenance department superintendent who keeps in close touch with the plant manager and his assistant. This contact gives him a general picture of conditions in the plant and enables him to judge the urgency of any work in question.

Now, a definite promise is made as to the date each job will be completed. This date is noted on the original order that is sent to the plant manager's office and also appears on the copy that goes to the shop foreman. This foreman is expected to complete the job on or before the date specified or present a good reason, at once, why the promise cannot be kept. Under this plan the factory departments know exactly when their equipment will be ready for use.

One man in each shop is assigned to small breakdown work which makes it unnecessary to take men off the larger jobs to handle emergency work. Taking the planning away from the master mechanic allows him to devote all his energies to getting the work done in a minimum amount of time.

Formerly, each foreman kept the time for his men and turned in the time cards each evening. This took quite a bit of time and was not very accurate, especially where one foreman was handling a number of men on different jobs. Under the present system each workman reports by phone to a clerk in the maintenance department office whenever he changes jobs. It allows the foreman to devote all his time to productive work and has not resulted in any increase in the clerical force.

A large map of the plant, with colored and numbered tacks to represent each member of the maintenance force, is hung in the maintenance department office. The timekeeper moves the tacks as the men report, giving the superintendent a graphic picture, at all times, of the location of the various mechanics at work. The map also helps to locate men needed for emergency work.

On all major jobs, an estimate of cost is prepared by the maintenance superintendent and submitted to the plant manager for approval before work is started. Foremen of the various shops are consulted at the time an estimate is prepared. After a job is approved the estimated cost is given to the man in charge of the work who is expected to keep within this figure. This acts not only as a spur to the men doing the work but discourages the habit of changing or adding to the cost of a job after the original plans have been approved.

An analysis of the cost of each job is made at the end of each month. Any job that appears to be too high is brought up for discussion at a meeting of the maintenance department foremen.

We believe that our experience has helped to prove that proper planning of maintenance work pays dividends and deserves more thought than it is now receiving.

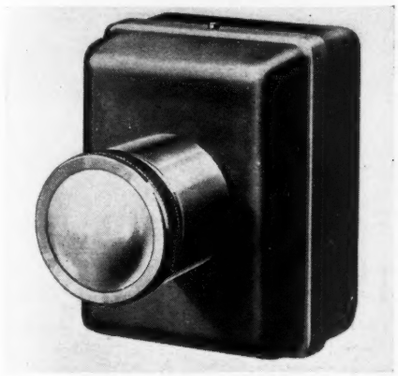
EQUIPMENT NEWS

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these devices, which are designed to improve plant operation or reduce operating and maintenance costs.

Allen-Bradley Light Source

A LIGHTING unit for use with photo-electric relays up to a distance of 30 feet has been announced by the Allen-Bradley Company, 1311 South First St., Milwaukee, Wisconsin, and is known as the Bulletin 875 light source. It has a plano-convex lens and a socket to receive an automobile lamp, all inclosed in a cabinet of pressed steel. The cover and lens mounting can be removed by loosening one set screw. When used on power and light circuits, the light source requires a transformer for stepping the line voltage down to 6 volts. A transformer can be furnished with the equipment. This light source was developed for use with the Allen-Bradley Bulletin 880 photo-electric relay.

In addition to the pressed-steel



cabinet, this light source is available, with step-down transformer, in a cast-iron cabinet of weatherproof construction for use outdoors. The cast iron is cadmium plated to prevent corrosion.

■

Elwell-Parker Fork-Type Trucks

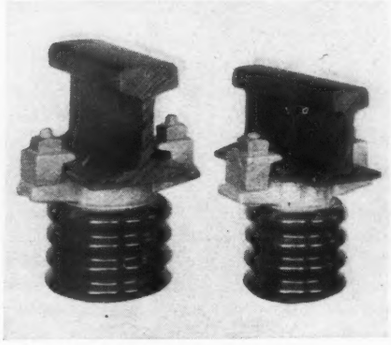
FORK-TYPE trucks of 3-ton capacity, known as Type ERN, have been announced by The Elwell-Parker Electric Company, Cleveland, Ohio. They are built to accommodate either a storage-battery or gasoline-electric unit as a power source. Forks are made in various lengths and spreads to accommodate any kind of material. After the forks are thrust under the load, they may be tilted back 30 deg. in order to carry the load safely to its destination.

Loads may be tiered to a height of 5 ft. When higher tiering is necessary, the uprights can be lengthened to suit. Telescoping uprights can be furnished for applications where headroom is limited. The tilt and hoist features are accomplished by one unit. The lift is controlled by cable, while the tilt is governed by rack and pinion.

■

Delta-Star Collector-Rail Supports

DELTA-STAR Electric Company, 2400 Block, Fulton St., Chicago, Ill., has developed a line of unit-type, collector-rail supports. The insulator units are of the standard-indoor, porcelain type. The center-bolt construction requires one mounting bolt and provides for any angle adjustment of the fittings. The supports are designed to allow for expansion and contraction of the rails without binding. The clamps are adjustable so that several sizes of rails can be used with each clamp. In the event of breakage, the insulators can be replaced without scrapping the entire support.

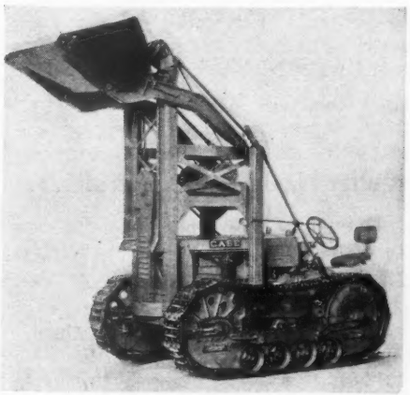


Trackson High Shovel on Case Tractor

THE TRACKSON COMPANY, 1320 South First St., Milwaukee, Wis., announces that its High Shovel is now adapted to the Case-Trackson, heavy-duty crawler tractor.

The complete unit has the advantages of a low-lift shovel in digging and a sufficiently high dumping clearance (7 ft.) to load high-body trucks from the sides or rear. The bucket is held close to the tractor to insure positive digging action and proper balance. The mechanism that actuates the shovel is at the front of the tractor. This design permits independent movement of the bucket whether the tractor is in motion or standing still.

The bucket is controlled by a single



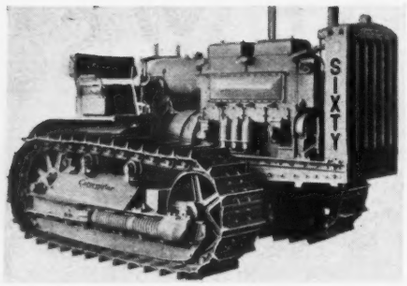
lever, rising in 10 seconds and lowering in 5, and has a lifting capacity of 3,000 lb. The shovel unit in no way interferes with the drawbar operation of the tractor.

■

Caterpillar Diesel Tractor

THE CATERPILLAR TRACTOR Company, Peoria, Ill., has added the Caterpillar Diesel Sixty Tractor to its line. This model is the only Diesel-powered tractor it manufactures, and does not displace the Standard Sixty, powered by gas engine.

Changes in the design of parts other than the engine have been made. Frame side members of the Diesel Sixty differ from the Standard Sixty; radiator design is modified; a heavy equalizer



spring is used instead of an equalizer bar; tracks are of 34 sections; recoil springs are tandem type.

The fuel injection apparatus is Bosch equipment, adapted to Caterpillar requirements. Supplied with each tractor is an extra set of fuel pumps and nozzles—adjusted, sealed and interchangeable as units—avoiding necessity for field adjustments to the fuel injection system. Should a fuel pump or nozzle require adjustment in the field one of these units may be substituted and the defective one returned to the Caterpillar Tractor Company for servicing.

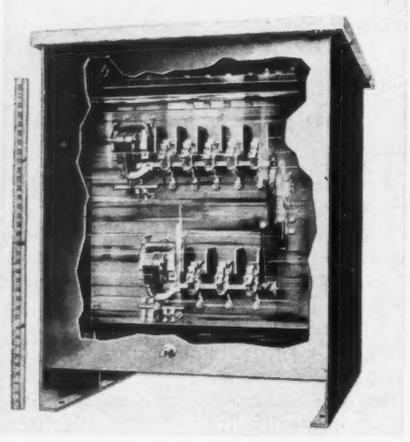
The Caterpillar Diesel Sixty tractor develops 63 maximum hp. and 75 maximum belt hp. Its shipping weight is approximately 25,000 lb.

The Diesel engine is started by a small two-cylinder Caterpillar engine, mounted on the left side of the main power unit. Connection to the main power plant is automatically disengaged when operating speed is reached.

■

Cutler-Hammer A.C. Explosion Proof Starter

AN OIL-IMMERSED, explosion-proof, auto-transformer-type, automatic starter for a.c. squirrel-cage motors has been announced by Cutler-Hammer, Inc., 253 North 12th St., Milwaukee, Wis. It is designed to comply with the Underwriters' requirements for Class 1, Group D installations and provides a 6-in. head of oil above the contacts. The starter incorporates an oil-level indicator and an outside spout for replenishing the oil without removing the cover in its construction. Terminals are located above the level of the oil so that the oil will not deteriorate the rubber insulation. The starter panel consists of a three-pole and a five-pole contactor, each mounted on a slate panel. Both contactors are locked so that they cannot be closed at the same time.



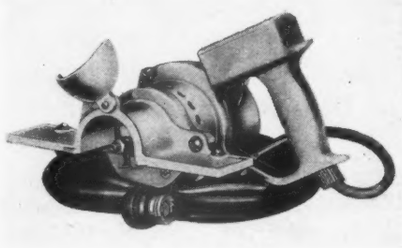
The auto-transformer and overload relays are mounted on a bracket at the rear of the panel. The panel is fastened to an angle-iron frame, which fits into channels at the sides of the tank.

Applications for the starters include their use with motors in cement mills, flour mills, starch plants, oil refineries, or other locations where explosive or corrosive conditions are prevalent.

■

SpeedWay Type 404 Groover

SPEEDWAY MANUFACTURING COMPANY, 1834 South 52nd Ave., Cicero, Ill., announces the Type 404 groover for weather-strip grooving. It is provided with an automatic switch



that opens the circuit when the operator's grip is relaxed. The tool is designed for heavy duty and has a maximum capacity of ½-in. square cuts. Standard equipment includes either one cutter or an 8-ft. cord with plug, as desired. The motor operates on either a.c. or d.c. supply.

■

Economy Hand-Operated Hoist

ECONOMY Engineering Company, 2653 West Van Buren St., Chicago, Ill., announces a hand-operated hoist designed to eliminate the strain and danger involved in handling chucks.

The lift base is 20 in. wide and 40 in. long with 3-in. wheels. The rear wheels are mounted on swivels, and those at the front end are fixed. The top of the boom is 76 in. above the floor, enabling the chuck to be raised high enough for an ordinary lathe. The saddle for the chuck is 6 in. wide

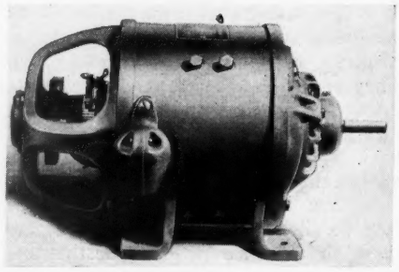
and is large enough to accommodate chucks weighing up to 200 lb. The mast is arranged to permit the end of the boom to move to a point about 6 in. from the centerline of the machine on either side. This feature aids in locating the chuck in the proper position for attaching it to the lathe shaft. The hoisting gear is attached to the movable part of the mast to insure cable alignment at all times between the drum and overhead sheave wheel. Loads are raised and lowered by turning a crank. A ratchet and friction-disk arrangement automatically holds the load wherever desired. When picking up a chuck, the belt is lowered and spreads as it comes in contact with the floor or the wood platform of the lift.

■

Reliance D. C. Motors

THE RELIANCE ELECTRIC & ENGINEERING Company, 1088 Ivanhoe Road, Cleveland, Ohio, has developed a line of small d.c. motors to supplement the Type T heavy-duty motors.

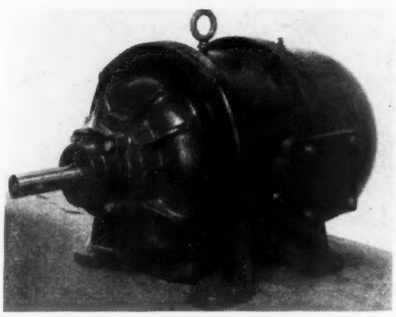
The motors are built in sizes from ½ hp., 1,750 r.p.m. to 3 hp., 1,750 r.p.m. for constant- or adjustable-speed operation. They are provided with ball or sleeve bearings and may be had in either the open, semi-inclosed, or fully-inclosed construction A feature is the refillable-type commutator. If the copper bars become damaged or badly worn, they may be removed and replaced. Two brushes per stud facilitate commutation.



Westinghouse Totally Inclosed Fan-Cooled Motors

TOTALLY inclosed, fan-cooled, squirrel-cage motors for use in explosive atmospheres have been announced by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. They have been designed in accordance with the specifications of the National Board of Fire Underwriters for use in Class I, Group D, hazardous locations.

Free passage of cooling air is assured because of the provision of air passages and spaces between the guard and the non-sparking aluminum-alloy fan. Air inside the motor is kept in constant circulation by fan blades on each end of the rotor. Bearings are of the cartridge type and are located on the outside of the bearing bracket where the heat is dissipated in the cool air stream. The pre-wound primary core is inter-



changeable and renewable. The conduit box is designed so that it may be turned in any direction to receive conduit. The motors operate efficiently either indoors or outdoors.

■

Robins Belt-Trainer

A DEVICE, known as a belt-trainer, that automatically keeps the return side of a belt conveyor in line and, therefore, prevents wear of the belt's edges has been announced by the Robins Conveying Belt Company, 15 Park Row, New York, N. Y. Belt-trainers are substituted for idlers at specific points on the return side of the belt.

The belt-trainer consists of a tubular roller mounted upon a single anti-friction bearing at its center. This bearing is pivoted internally upon a fixed swivel pin located on the center line of the conveyor and inclined forward about 30 deg. Therefore, the roller is not only free to rotate on the bearing but also is free to rock about the pivot. When the weight of the belt falls more upon one side of the pivot than the other, the roller rocks downward on the heavy side. At the same time, because of the inclination of the swivel pin, the roller moves forward on the downside and backward on the upside, thus becoming skewed with relation to the belt and causing the belt to move back to the conveyor center line.

The unit does not oscillate continually as might be expected but automatically assumes a stable position. The belt also, instead of veering from side to side, finds its central position and runs true.

Under normal conditions, successful training of the return strand is attained by substituting one belt-trainer for every eighth return idler, or about every 80 ft. Under adverse conditions, it may be necessary to use one belt-trainer in place of every fifth return idler, or about every 50 ft. The devices are available in sizes to suit belts 12 to 48 in. wide.

■

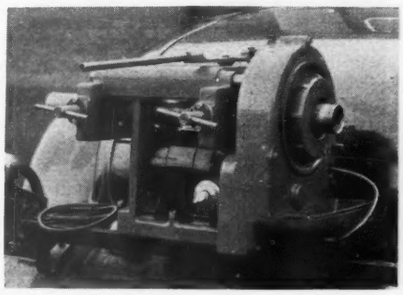
General Electric "Senior" Floodlight

THE "SENIOR" floodlight, designed for general-utility floodlighting and employing a 200-watt incandescent lamp, has been announced by the General Electric Company, Schenectady, N. Y. This projector is intended for uses in which light requirements do not necessitate the larger, standard units.

The floodlight weighs approximately 6 lb., measures less than 15 in. in height with its supporting stand, and has a depth of 12½ in. from the center of the lens to the tip of the lamp holder. The diameter of the heat-resisting lens measures 10 in. A 200-watt, inside-frosted, general-service incandescent lamp with a 6-in. light center and a medium screw base is used. Vertical and horizontal adjustments are obtained with wing nuts on the swivel support and base. The base, swivel support, and casing of the projector are finished in dark green, baked enamel.

Axelson Portable Pipe Threader

AXELSON Manufacturing Company, Ltd., Los Angeles, Calif., announces a portable pipe threader that weighs 190 lb. and will thread sizes of pipe ranging from ½ to 2 in. The unit is designed to receive its electrical power from a light socket. The machine uses the method of revolving the die around the pipe for its principle of operation. The material to be threaded is held in



place by two self-centering jaw chucks. Attachments furnished are a pipe cutter, a reamer, and six dies for threading ¼-, ¾-, 1-, 1¼-, 1½-, and 2-in. pipe. A universal, reversible motor is used.

■

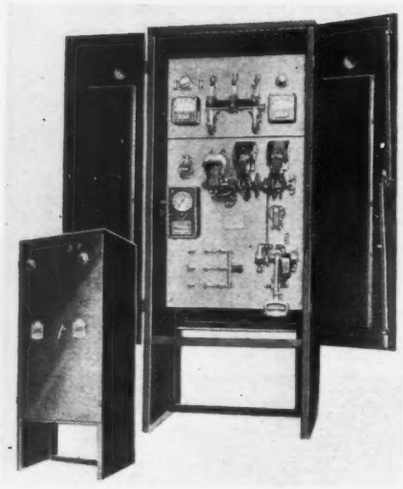
Adsco "Pipe-Kote"

ANNOUNCEMENT has been made by the American District Steam Company, North Tonawanda, N. Y., of a protective paint for use on steam and hot-water pipe lines. The product has been named "Pipe-Kote" 505. Features claimed are that it is impervious to heat generated by steam; practically immune to the action of moisture, dilute acids, and alkalis; and, despite its hard coating, sufficiently elastic to expand and contract with the pipe without cracking or peeling. Although the paint is recommended especially for use on steam and hot-water lines, it may be used on gas and water mains, stacks, boiler fronts, bridges, and other surfaces exposed to extreme or rapid changes of temperature and atmospheric conditions.

■

Cutler-Hammer Fire-Pump Starters

A LINE of a.c. and d.c. manual, and combined manual and automatic motor starters for fire-pump service is announced by Cutler-Hammer, Inc., 253 North 12th St., Milwaukee, Wis. A dust-proof and splash-proof, floor-type inclosure protects the mechanism. Other characteristics of the line are double-throw, main-line knife switches, low-voltage protection, circuit-breaker over-



load protection, carbon-to-copper contacts, and pilot lights. The combined manual and automatic types are so arranged that, should the motor stop because of low voltage, the equipment is transferred immediately to automatic operation. On resumption of voltage the equipment will re-start if the pressure is low.

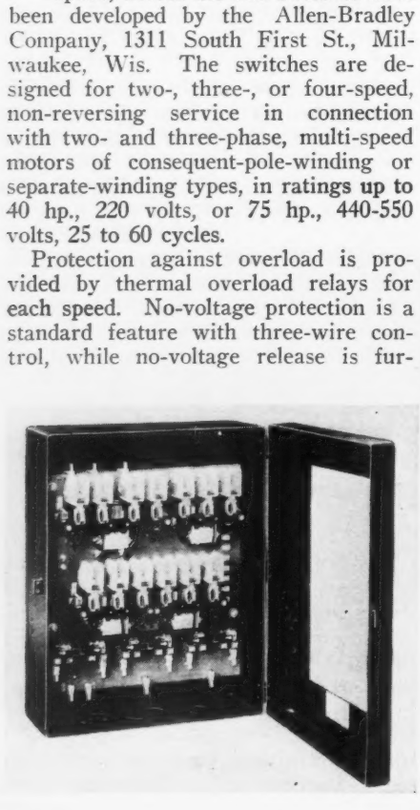
The starters are approved by the Underwriters' Laboratories and by the Associated Mutual Fire Insurance Companies.

■

Allen-Bradley Automatic Switches for Multi-speed Motors

BULLETIN 715, automatic, multi-speed, across-the-line switches have been developed by the Allen-Bradley Company, 1311 South First St., Milwaukee, Wis. The switches are designed for two-, three-, or four-speed, non-reversing service in connection with two- and three-phase, multi-speed motors of consequent-pole-winding or separate-winding types, in ratings up to 40 hp., 220 volts, or 75 hp., 440-550 volts, 25 to 60 cycles.

Protection against overload is provided by thermal overload relays for each speed. No-voltage protection is a standard feature with three-wire control, while no-voltage release is furnished with two-wire control. The units consist of two or more magnetic switches operated from control stations having three, four, or five pushbuttons. An optional feature is a slow-speed-start interlock, which compels the operator to follow a definite sequence of speed steps in starting the motor.

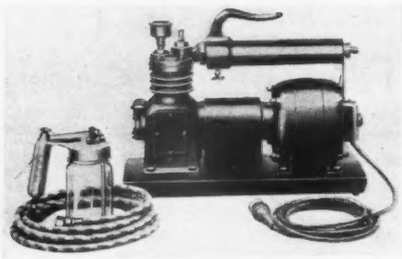


■

DeVilbiss Spray-Painting Outfit

AN IMPROVED, portable, spray-painting outfit, known as the DeVilbiss NC-607, has been announced by The DeVilbiss Company, Toledo, Ohio. This unit is recommended for use by master painters, decorators, contractors, and builders as supplemental equipment for touch-up work on small-sized painting or refinishing jobs.

It is electrically driven and may be

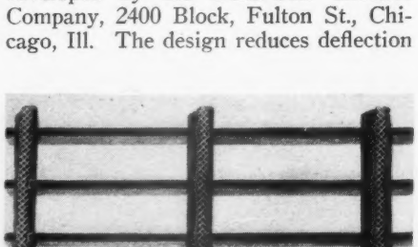


operated from any light socket. The compressor and motor are mounted on a rubber-footed metal base.

■

Delta-Star Floor Grating

STEEL floor grating with welded crossbars of truss formation has been developed by the Delta-Star Electric Company, 2400 Block, Fulton St., Chicago, Ill. The design reduces deflection



at the panel joints, and tends to eliminate tripping hazards. The grating is machine made.

■

Wright Screw Hoist

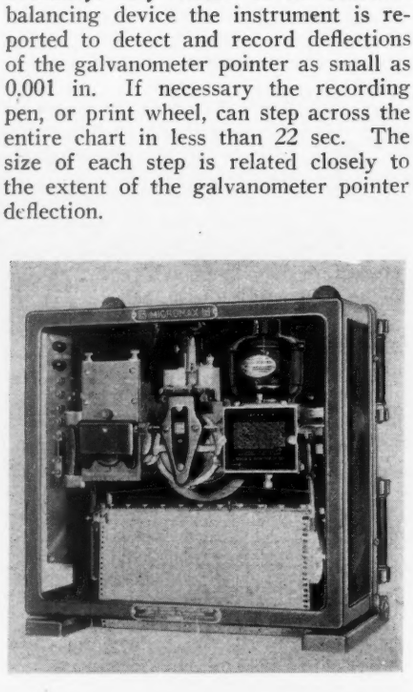
MODEL 30 screw hoist, announced by the Wright Manufacturing Company, Bridgeport, Conn., is applicable to general repair work where a

hoist must be carried about and operated in different places, and to horizontal work, such as moving heavy loads on rollers or skids. The hoist is designed on the worm-wheel principle and will hold the load at any point. Load-chain guards shroud the complete upper half of the load wheel and prevent the load from riding out of the load-wheel pockets.

■

Leeds & Northrup "Micromax" Potentiometer Pyrometer

"MICROMAX" is the name of a potentiometer pyrometer, announced by the Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa., that requires no manual adjustments or daily attention. The instrument circuit is standardized automatically every 45 min. or less, giving a closer adjustment than can be obtained manually. By virtue of its sensitive balancing device the instrument is reported to detect and record deflections of the galvanometer pointer as small as 0.001 in. If necessary the recording pen, or print wheel, can step across the entire chart in less than 22 sec. The size of each step is related closely to the extent of the galvanometer pointer deflection.



Barber-Colman "Barcol" Two-Temperature Thermostat

A TWO-TEMPERATURE thermostat, designed for use in buildings where it is economical to have the temperature lower at night than in the daytime, has been developed by Barber-Colman Company, of Rockford, Ill.

The thermostat consists of two bimetallic-element units. One element is adjusted to control a range from 60 deg. F. to 80 deg. F., and the other the range of from 50 deg. F. to 70 deg. F. Other ranges can be supplied. A switch inside of the thermostat, actuated either by electromagnets or by a manual lever on top of the case, determines which unit shall control the temperature of the room.

In installations where large numbers

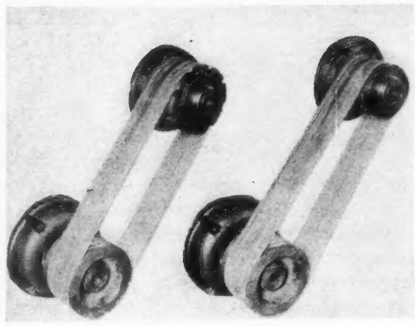
of two-temperature thermostats are used in the same building, change of control may be accomplished simultaneously in all thermostats by means of the switching magnets with which each is equipped. The manual switch upon each thermostat makes possible the placing of individual instruments on either day or night range if a room is to be occupied during the evening when the rest of the building has been placed under control of the night range.

The thermostat is housed in a case of molded phenolic resin and mounted upon a base of the same material.

■

Hammond Variable-Speed Drive

HAMMOND MACHINERY BUILDERS, INC., 1600 Douglas Ave., Kalamazoo, Mich., announces a multi-V-belt, variable-speed pulley drive capable of transmitting up to 15 hp. An



unlimited number of speeds may be obtained within its ratio of 1⅓ to 1. The maximum recommended speed is 3,000 r.p.m. The device was developed especially for use with polishing, buffing, and grinding machines. The speed of such machines, when driven through the variable-speed pulley, may be varied to any desired value between either a 1,800- to 2,700-, or 2,000- to 3,000-r.p.m. speed ratio.

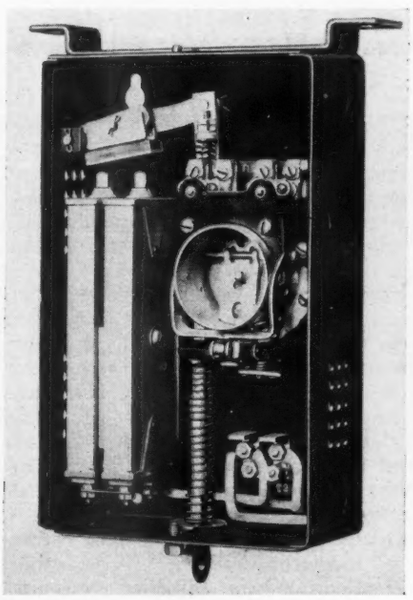
■

Allen-Bradley Treadle-Operated Controllers

BULLETIN 500 treadle-operated controllers, announced by the Allen-Bradley Company, 1311 South First St., Milwaukee, Wisconsin, provide control of speeds of sewing machines, small tools, winding machines, and similar equipment driven by d.c. or universal motors. Operation of the treadle compresses a graphite-disk resistor, which allows a stepless variation in motor speed.

A self-contained disconnect switch opens the motor circuit with a quick break of the "off" point, and a self-contained short-circuiting switch bypasses the resistance at full speed.

The controllers are made in five sizes,



the largest rated at ½ hp. and the smallest at $\frac{1}{20}$ hp. The $\frac{1}{20}$ hp. controller is a self-contained unit for placing on the floor, and is suitable for controlling sewing machines and small equipment, such as jewelers' lathes and dental equipment; it is equipped with treadle, cord, plug, and motor attachment plug.

The illustration shows a size D controller for treadle operation, with the cover removed. This size is mounted on the under side of a table or a machine.

■

SpeedWay Type 403 Blower

TYPE 403 blower, developed by the SpeedWay Manufacturing Company, 1834 South 52nd Ave., Cicero, Ill., is designed for cleaning loose dirt

from machinery, motors, shelves, and so on. The blower is of all-steel construction. A soft-rubber nozzle covering prevents short circuiting during the cleaning of switches or wiring. The unit has a pistol grip and a thumb-operated toggle switch. The motor operates on either a.c. or d.c. supply. Total weight of the unit is 5 lb. Standard equipment includes an 8-ft., rubber-covered cord with a soft-rubber plug.

■

General Electric Steel Clamp and Expansion Washer

TWO DEVICES for maintaining a constant-contact pressure in electrical buses and connections during varying current loads have been announced by the General Electric Company, Schenectady, N. Y. The first of these is a spring clamp of non-magnetic steel designed for use on buses and similar connections where this method of joining conductors can be used. The body of the clamp is shaped so that it will distribute the contact pressure independent of the spring action of the bolting lugs. The second device is an expansion washer for use on bolted connections; one washer is placed under the head and another under the nut of the bolt. The washers measure 1½ in. in diameter and are proportioned to provide full tension up to the elastic limit of a regular ½-in. steel bolt.

Hammond "Bichronous" Electric Clocks

TWO WALL models of "Bichronous" synchronous electric clocks, especially designed for industrial use, have been announced by The Hammond Clock Company, 2915 North Western Ave., Chicago, Ill. The "Clarion" model has a brown mahogany case and a 12-in. square dial. The "Sentinel" model, which is available in a walnut, oak, or mahogany case, has a 14-in. dial visible from a distance of 150 ft. Both models are provided with the "Bichronous" feature which provides a controlled source of energy during interruptions of current supply, sufficient to keep the clock running accurately for a 30-min. period.

■

Allen-Bradley Drum Reverse Switches

DRUM reverse switches, designated Bulletin 350, for across-the-line reversing of a.c. and d.c. motors and for reversing service in connection with magnetic starters, have been announced by the Allen-Bradley Company, 1311 South First St., Milwaukee, Wis. For direct handling of motor currents the switches have a maximum a.c. rating of 5 hp. at 110 volts, 10 hp. at 220 volts, and 15 hp. at 440-550 volts. They may be used with d.c. motors up to 3 hp. at 115 volts, and 5 hp. at 230 volts. For reversing service in connection with automatic starters the d.c. ratings may be increased.

The entire drum, including all contacts, drum segments, and terminals, is supported by a top bearing plate. This construction allows the inclosing cabinet to be omitted when the switch is to be built into a motorized machine.

■

Cutler-Hammer Attachment Cap With Hand Grip

AN UNBREAKABLE attachment cap with a hand grip, known as Catalog 7761, has been announced by Cutler-Hammer, Inc., 253 North 12th St., Milwaukee, Wis. It is made of soft, resilient rubber with its blades fastened to a bakelite disk imbedded in the rubber base. The hand grip is 1¾ in. long. The cap is rated at 15 amp. at 125 volts and 10 amp. at 250 volts. It is available with cord openings for either 11/32- or 13/32-in. cord.

■

General Electric Indoor Lighting-Control Relay

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., announces the CR7505-D3 indoor lighting-control relay. It is designed to turn artificial lights on and off automatically within a room or building according to the light intensity.

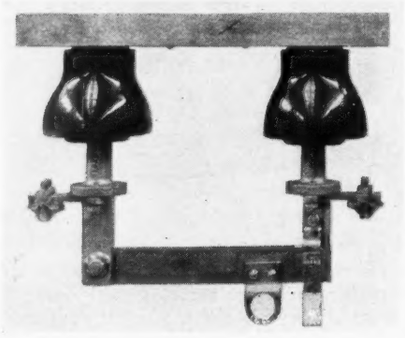
Photo-electric and pliotron tubes are used. The auxiliary equipment includes two potentiometers adjustable from the front of the inclosing case; a sensitive relay; and a normally open contactor with two insulated, single-pole interlocks. Also included are a transformer and resistors. One of the potentiometers is for adjusting the equipment to compensate for the additional illumination which will fall on the photo-electric tube when the artificial lights are turned on. The relay can be supplied to operate on 110- or 220-volt circuits at 25 or 60 cycles. The contactor is rated 15 amp. on 110- or 220-volt, a.c. supply.

■

Champion Disconnecting Switch

THE CHAMPION SWITCH COMPANY, Kenova, W. Va., has developed a line of 7.5 kv., 200 amp., single-pole, underhung, stick-operated disconnecting switches for rural distribution service.

The wet-process, interchangeable insulators are of the single-piece form. The switch parts are fastened with nonferrous bolts to the insulator pins. The lugs are of the solderless compression type, and the contacts are full-floating, self-aligning. The blade is provided with a guide at the contact end.



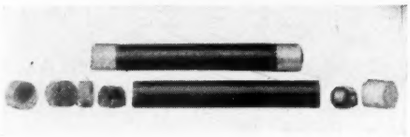
■

General Electric Spring-Type Fuse

A FUSE for potential-transformer primary circuits from 4,501 to 23,000 volts, in combination with current-limiting resistors, has been announced by the General Electric Company, Schenectady, N. Y. It consists primarily of a fiber tube with brass end caps, within

which are a spring-driven drum, a filament, and a fuse link embedded in a granular filler.

Some features of the fuse are high-speed operation, high interrupting capacity, and the low operating point at which it gives over-current as well as short-circuit protection. When the fuse operates, the filament melts first, thus causing an arc to strike and to sever the fuse link opposite the arcing edge on the brass cup. This action releases the fuse link, which is reeled in completely by

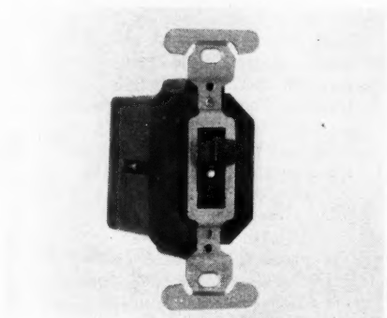


the spring-driven rotating drum in 0.1 sec. through the granular filler, and smothers any arc that may be established.

■

General Electric Mercury Tumble Switch

THE GENERAL Electric Company, Schenectady, N. Y., announces a flush tumble switch similar to the standard flush tumble switch except that the circuit is made and broken by mercury in a sealed tube. The tube is tilted by the handle when the switch is operated. The switch has a composition box slightly deeper than the customary switch boxes. It is made only in the single-pole type.

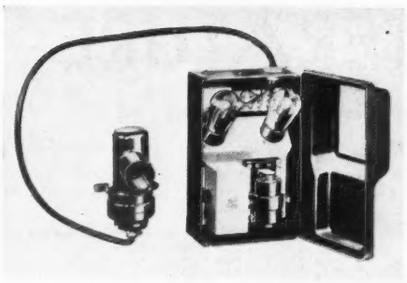


Features claimed are silent operation, long life, and making and breaking of circuit without an open arc.

■

Allen-Bradley Pilot-Control Relay

BULLETIN 880 photo-electric relay, developed by the Allen-Bradley Company, 1311 South First St., Milwaukee, Wisconsin, is applicable to counting relays, limit switches, alignment controls, sorting devices, automatic smoke detectors, position indicators,



safety devices, automatic inspection devices, traffic signal relays, and many other uses. It is operated by a change in intensity of light from a suitable light source. A change of 10 foot-candles is required for positive operation; the light may be either direct or reflected.

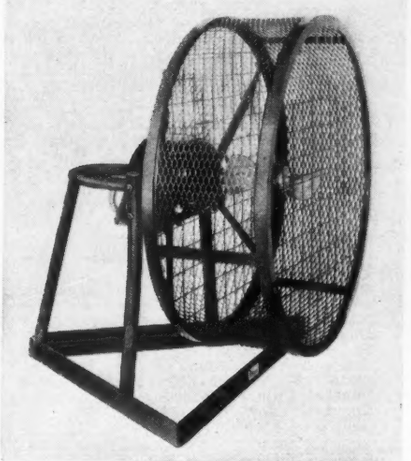
By adjusting a condenser, the relay can be made to operate at various values of light intensity. No appreciable power is consumed when the relay contacts are open. The capacity of the contacts is 10 amp. at 110 volts, alternating current, non-inductive load.

The relay is also available with all the parts, including the photo-electric tube, inclosed in a waterproof cast-iron case with window, for outdoor operation.

■

American Propeller Floor-Level Aerospots

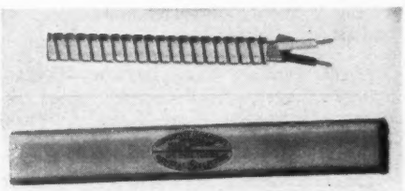
PORTABLE ventilators, known as "Paragon Floor-Level Aerospots," that may be attached to the side of the wall or suspended from the ceiling, have been announced by The American Propeller Company, South Bend, Ind. Typical applications may be found in ice-cream plants, meat-packing plants, laboratories, and engine rooms. Guards are of welded-steel. An automatic switch protects each unit from overload or undervoltage. Two sizes are available. One size uses a $\frac{1}{4}$-hp. motor and a 24-in. diameter propeller. In the other size a $\frac{1}{8}$-hp. motor drives a 20-in. diameter propeller.



General Electric Oval Tubing and Oval BX Cable

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has announced the addition of oval tubing and oval BX cable to its line of wiring materials.

Oval tubing is a thin-walled, rigid, metal raceway designed for under-plaster extension installations in walls and ceilings. It is installed by cutting a groove in the plaster, inserting and fastening the tubing, and covering it



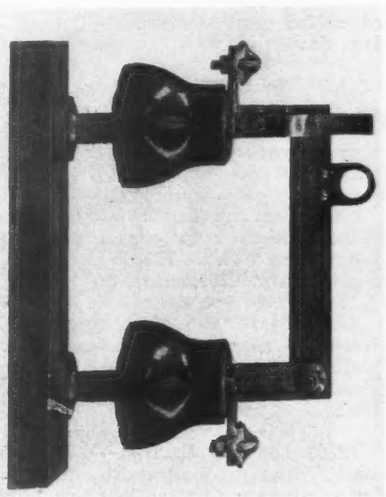
with a layer of plaster. A specially designed toggle provided with a loop holds the tubing securely in place. Tubing may be used in direct connection with rigid conduit by joining the two with one fitting.

The oval cable is adaptable to all exposed or surface wiring. It may be installed in the plaster without channeling the walls and ceilings.

■

Champion Single-Pole Disconnecting Switch

A 7.3 KV., single-pole disconnecting switch for top or side mounting has been developed by the Champion Switch Company, Kenova, W. Va. Single-



piece, wet-process insulators with switch parts held by non-ferrous bolts; self-aligning contacts; blade guides; and solderless, clamp-type terminal lugs conform to the latest engineering requirements.

TRADE LITERATURE

For copies, address the manufacturers concerned

■

(359) WELDING — Bulletin WF-2, 4 pages, Midwest welding fittings.—Midwest Piping & Supply Company, Inc., 1450 Second St., St. Louis, Mo.

(360) POWER TRANSMISSION—*Catalog* 100, 76 pages, "Heliocentric" speed reducers.—Universal Gear Sales Corporation, Indianapolis, Ind.

(361) GRAPHIC INSTRUMENTS—Bulletin 931, 4 pages, flush-type graphic instruments.—The Esterline-Angus Company, Indianapolis, Ind.

(362) PIPE TOOLS—8-page booklet, Catalog No. 32 (condensed), added line of tools and improvements in early models.—The Borden Company, Warren, Ohio.

(363)—BALL BEARINGS—66-page booklet, dimensions, load data and list prices of New Departure bearings.—New Departure Manufacturing Company, Bristol, Conn.

(364) AUTOMATIC SWITCHES—Bulletin 715, 4 pages, across-the-line switches, contactors and automatic relays.—Allen-Bradley Company, Milwaukee, Wis.

(365) AUTOMATIC STARTERS—Bulletin 742, automatic increment starters for use on network systems, and for starting squirrel-cage motors; gives engineering data and construction features.—Allen-Bradley Company, Milwaukee, Wis.

(366) GEARS—8-page pamphlet, details of welded gear construction.—Lukenweld, Inc., Coatesville, Pa.

(367) PYROMETER — 16-page booklet, features of the Brown Potentiometer Pyrometer.—The Brown Instrument Company, Wayne and Roberts Aves., Philadelphia, Pa.

(368) ELECTRIC TRUCKS—12-page illustrated booklet, electric cranes, fork trucks and tractor models.—Elwell-Parker Electric Company, Cleveland, Ohio.

(369) MATS AND MATTING—Pamphlet No. 18, 4 pages; rubber corrugated and perforated mats for switchboard matting.—Republic Rubber Company, Youngstown, Ohio.

(370) LEATHER BELTING—"Belt User's Book," 70 pages; illustrated handbook giving engineering data on belts and belting upkeep.—J. E. Rhoads & Sons, 35 N. Sixth St., Philadelphia, Pa.

(371) WELDERS—Single-page pamphlet, features of General Electric Arc Welders, Types WD-21, WD-22, WD-23, WD-24.—General Electric Company, Schenectady, N. Y.

(372) FANS—Bulletin No. 381, 20 pages; engineering data and performance charts of the "Design 4 Silentvane Fan."—B. F. Sturtevant Company, Hyde Park, Boston, Mass.

(373) ELECTRIC MELTING EQUIPMENT—Bulletin TC-11, 8 pages, describes and rates electrically heated melting pots, thermometer calibration tanks, ovens, and the like.—Harold E. Trent Company, 618 N. 54th St., Philadelphia, Pa.

(374) WASHERS—4-page pamphlet, types 11, 12, 15 and 20 lock washers.—Shakeproof Lock Washer Company, 2501 N. Keeler Ave., Chicago, Ill.

(375) GAS WELDING AND CUTTING EQUIPMENT—32-page bulletin; illustrations, ratings, prices and applications of gas welding torches, torch tips, gas mixers, and cutting equipment.—Torchweld Equipment Company, 224 North Carpenter St., Chicago. Ill.

(376) FLEXIBLE COUPLINGS—Bulletin 47, 24 pages; engineering data, performance charts, and illustrations of Morse Flexible Couplings. — Morse Chain Company, Ithaca, N. Y.

(377) ELECTRIC FLOW METER—6-page folder, describes Brown Electric Flow Meter, and announces "Power Plant Instrument Data Book," to be had upon request.—The Brown Instrument Company, Wayne and Roberts Aves., Philadelphia, Pa.

(378) WATER-COOLING EQUIPMENT——34-page booklet, Bulletin No. 6-E; illustrations and engineering data of Binks spray cooling towers and accessories.—Binks Manufacturing Company, 3114 Carroll Ave., Chicago, Ill.

(379) LIGHT-SENSITIVE CELL UNIT—Leaflet for "Dunco" catalog; illustrations, diagrams, and installation directions of the "Dunco" Light-Sensitive Cell Unit.—Struthers Dunn, Inc., 139 N. Juniper St., Philadelphia, Pa.

(380) COMPRESSOR UNIT—Leaflet, Bulletin 10A.—Model GV-80 Quincy Automatic, Two-Stage, Air-Cooled Unit, dimensions and ratings.—Quincy Compressors, Quincy, Ill.

(381) SPIRAL WELDED PIPE—Armco Engineering Bulletin No. 4, Volume I, 8 pages. Report upon survey made in the Middle Atlantic States to ascertain the probable life of galvanized coatings on the interior of culverts.—American Rolling Mill Company, Middletown, Ohio.

(382) INSTRUMENTS—Catalog 2025, 20 pages, thermometer controllers for temperature ranges up to 1,000 deg. F.—The Bristol Company, Waterbury, Conn.

(383) FLOOR PLATE—Folder, four-way, non-skid floor plate, description and sizes.—Inland Steel Company, Chicago, Ill.

(384) POWER TRANSMISSION — Booklet, 148 pages, engineering specifications and data on "Vim" short-center drives.—E. F. Houghton & Company, Philadelphia, Pa.

(385) INSTRUMENTS—Catalog No. 2050, 28 pages, pyrometer controllers for temperature ranges up to 3,000 deg. F.—The Bristol Company, Waterbury, Conn.

(386) INSTRUMENTS—Catalog No. 2002, 56 pages, electric flowmeters operating on the inductance-bridge principle—The Brown Instrument Company, Philadelphia, Pa.

(387) CONTROL — Leaflet, Bulletin 500, treadle-operated controllers for use with d.c. or universal motors up to ½ hp.—Allen-Bradley Company, Milwaukee, Wis.

(388) LIGHT SOURCES—Leaflet, Bulletin 875, light sources for photo-electric relays.—Allen-Bradley Company, Milwaukee, Wis.

(389) CIRCUIT BREAKERS—Bulletin 6EA—720B, 12 pages, d.c. high-speed circuit breakers. — General Electric Company, Schenectady, N. Y.

(390) ELECTRIC FURNACES — Bulletin 6EA—1324 A, 4 pages, air-draw furnaces for quantity drawing of steel parts at temperatures up to 1,200 deg. F.—General Electric Company, Schenectady, N. Y.

(391) FIRE PROTECTION — Booklet, 78 pages, regulations for the installation, maintenance, and use of first-aid fire appliances as recommended by the National Fire Protection Association.—National Board of Fire Underwriters, 85 John St., New York, N. Y.

COMING EVENTS

International Acetylene Association—Thirty-second Annual Convention, Congress Hotel, Chicago, Ill., Nov. 11-13. Headquarters, 30 East 42nd St., New York, N. Y.

American Society of Mechanical Engineers—Annual meeting, New York City, Nov. 30 to Dec. 4. Secretary, Calvin W. Rice, 33 West 39th St., New York, N. Y.

Seventh Annual Conference on Welding—To be held by the Engineering Extension Department of Purdue University at Lafayette, Ind., Dec. 10-11. Professor in charge, W. A. Knapp, Purdue University, Lafayette, Ind.

Second International Heating and Ventilating Exposition—In conjunction with the American Society of Heating and Ventilating Engineers and the American Society of Refrigerating Engineers, Cleveland, Ohio, January 25 to 29, 1932. The exposition is under the direction of the International Exposition Company, Grand Central Palace, 46th St. and Lexington Ave., New York, N. Y.

MAINTENANCE ENGINEERING'S DATA SHEETS

Safe Practices for Materials Storage

Oils - Acids - Dry Materials

(Continued from the October issue)

Above-Ground Storage Tanks—If tanks are above ground and contain fuel oil conforming with the flash point requirements (150 deg. F. or above, closed cup), the National Fire Protection Association recommends that the minimum distance from the shell of the tank to the line of such adjoining property upon which there may be future construction should be one and one-fourth times the diameter of the tank. The maximum distance required is 125 ft. The minimum distance between the edge of a tank and the edge of any adjacent tank should conform to the following table:

Capacity of Tank in Gal.	Minimum Distance to Any Other Tank
300 or less	3 ft.
500 or less	3 ft.
1,000 or less	3 ft.
8,000 or less	3 ft.
12,000 or less	3 ft.
18,000 or less	3 ft.
24,000 or less	5 ft.
30,000 or less	10 ft.
48,000 or less	10 ft.
75,000 or less	13 ft.
100,000 or less	15 ft.
100,000 to 2,500,000	One tank diameter

For kerosene and gasoline storage much greater distances are required between tanks. These distances, however, have not been approved formally by the National Fire Protection Association.

Tanks above the ground should be arranged so that, in case of leakage at any point in the piping system, the tank will not be drained. If the tank itself springs a leak, provision should be made so that either the contents can be transferred to another tank or the escaping liquid will be collected within suitable dikes, retaining walls, or earth embankments built around the tank. Dikes should have a capacity at least 50 per cent greater than that of the tanks protected. No openings in the dike walls should be permitted.

The tank above ground, if not provided with some reliable means for preventing the transmission of flame into its interior, should have a comparatively light roof so that if an explosion should take place, the roof will give way without rupturing the tank walls. For the same reason it is advisable to use light manhole covers on the tank roof.

When well grounded, the gas-tight roofed tank should be practically immune from damage if struck by lightning.

Any kind of a tank roof must be well supported or it will collapse because of the expansion and contraction stresses and because of excess pressures to which it is subjected.

A water-cooling system may be provided to cool the tank in hot weather. In some installations it may be desirable to build the roof flat with upturned edges to hold a quantity of water.

Above-ground steel tanks should be made of galvanized steel, basic open-hearth steel, or wrought iron, in accordance with the requirements of the National Fire Protection Association. They should be coated on the outside with tar, asphaltum, or other rust-resisting material. Many companies now are using aluminum paint for the purpose because its heat-reflecting quality reduces evaporation losses. Every storage tank should be provided with a vent pipe. If a vent pipe is not permanently open, a suitable safety relief valve should be provided. The fill pipe should not be located within 5 ft. of any building opening; it should be preferably at one side, rather than directly in front of, such an opening and should terminate in a metal box or casting provided with a lock. Fill pipes should be protected at the openings with screens of corrosion-resisting metal.

Repair of Tanks—The National Fire Protection Association has recommended the following procedure to free any tanks of flammable and explosive vapors before making repairs:

(a) When the contents have been removed, the tank should be drained thoroughly. Should residual pools or a sediment of basic sludge remain, they should be removed with water from a hose line. A nozzle may be necessary, to dislodge the remaining sludge. During this and subsequent cleaning processes, workmen should operate from the outside only through manholes or hatches.

(b) Where steam is available, the tank should

MAINTENANCE ENGINEERING'S DATA SHEETS

Safe Practices for Materials Storage—Oils—Acids—Dry Materials

(Continued from the preceding page)

be closed and live steam blown into it or the space to be cleaned. Vent pipes should be provided and left open. Because the time for steaming will be determined by the foregoing, no definite rule is laid down to cover all contingencies, but the following table is recommended as covering average general conditions:

Where L = Length of the compartment in ft.
B = Breadth of the compartment in ft.
H = Depth of the compartment in ft.

The steaming time is arrived at by taking the number of hours given in the table under the actual size of the steam connection corresponding to the value given by LxBxH, or the volume in cu.ft. of the compartment to be steamed.

Value of LxBxH not Exceeding	Size of Steam Connection — 1 In. Hours Steaming	1¼ In. Hours Steaming	1½ In. Hours Steaming
30,000	20	14	10
40,000	26	18	13
50,000	32	22	16
60,000	38	26	19
70,000	44	30	22

In steaming tanks the last one-fifth of the steaming period should be carried out with the manhole plates or tank lids opened to the atmosphere. (Pipe connections should be blanked off.)

(c) Where steam is not available, the tank should be drained as previously mentioned and flooded with water, with both top and bottom hatches open, for a period of 24 hr. After flooding, all manhole plates and other covers should be opened, and the tank should be ventilated thoroughly by air under natural, forced, or induced draft for a period of at least 2 hr. No tank should be entered until it has been either steamed thoroughly or cleaned with water for a period of not less than 24 hr., except in cases of emergency, and then only by men protected by masks or breathing apparatus approved for such purposes by the U. S. Bureau of Mines.

(d) Following these processes specimens of air should be taken at a sufficient number of points within the tank, or other space to be repaired, to ascertain whether all flammable and explosive vapors have been removed. The majority of air specimens should be taken at or near the bottom of the tank and in all corners or pockets where vapor might settle.

The National Fire Protection Association regulations concerning repairs are as follows:

(a) Where a tank to be repaired adjoins another tank, no repairs should be made until the tank in question and all adjacent tanks have been freed from explosive or flammable vapors.

(b) In the event of repairs extending beyond a period of 24 hr., sampling tests should be repeated each morning before work is resumed or during the day at the discretion of the foreman.

(c) While repairs or cleaning operations (but not air sampling) are under way, a current of air under natural, forced, or induced draft should be circulated continuously through the tank. It is recommended that the compressor or other air unit have a minimum capacity of not less than 400 cu.ft. per min. of free air.

(d) No open lights or flames should be permitted within 50 ft. of an opening in any tank or space not conditioned for repair as previously outlined. Lights carried into tanks should be either electric or a type approved by the U. S. Bureau of Mines for use in gaseous mines. Electric lighting and flashlights may be used as accessories. If possible, all repairs should be made during daylight. Portable, connected electric lamps should be prohibited. Self-contained electric battery lamps may be used.

(e) No repairs of any kind involving the use of highly heated materials, tools employing open flames, or highly heated parts should be made until the foreman is provided with a permit signed by the superintendent.

Should an emergency require the entering of a tank or other space before it is thoroughly free of vapor, the person or persons entering should be protected with breathing apparatus approved by the U. S. Bureau of Mines in accordance with the instructions as to its use. A rope should be attached to the body of each man at work in the tank or each man entering the tank for rescue purposes. Persons at work within the tank should be under constant attendance.

(g) Where tanks contain heating coils or other obstructions, ropes attached to workmen may be omitted; but in such cases a sufficient number of men equipped with masks of approved, self-contained, oxygen-breathing apparatus should be on hand constantly.

(To be continued)

Courtesy National Safety Council